Safety Summary

The following **WARNINGS** and **CAUTIONS** appear throughout the text of this Instruction Book. Location is designated by the page number enclosed in parenthesis at the end of each notation.

CAUTION

Before mounting or installing Positioner, check nameplate data to make certain Positioner is suitable for application desired. DO NOT AT ANY TIME EXCEED THE RATINGS LISTED ON THE NAMEPLATE. (p. 3)

ATTENTION

Avant d'assembler ou d'installer le Positionneur, verifiez les donnees figurant sur le plaque d'identification, pour vou assurer que ce modele de Positionneur correspond bien a l'application que vous envisagez. ON NE DOIT EN AUCUNE CIRCONSTANCE DEPASSER LES VALEURS NOMINALES FIGURANT SUR LA PLAQUE D'IDENTIFICATION. (p. 3)

CAUTION

Certain installation methods will not stroke the actuator or cylinder to a fail-safe condition if the controller fails to send a signal. Bailey strongly recommends that, for increased safety, an installation method be selected that will provide a fail-safe mode upon loss of controller signal. (p. 5)

ATTENTION

Certaines methodes d'installation n'assurent pas le retour de l'operateur d'alimentation de puissance a une condition garantissant automatiquement la securite, au cas ou le controleur aurain une defillance et n'enverrait pas de signal. Dans l'interet de la securite, Bailey recommande avec insistance que la methode. (p. 5)

CAUTION

When making 01 and 02 output connections, S or E input connections, or gage connections, do not use Teflon tape to seal threaded fittings. Use only liquid or paste pipe sealant. Use of Loctite sealants, which are polyacrylate or acrylic diesters based, is not recommended. Water based Loctite sealant, such as Vibra-Seal No. 503 is acceptable. (pp. 5, 7)

ATTENTION

Pour les raccordements de debits 01 et 02, des entrees S ou E, ou des indicateurs, ne pas employer du ruban de teflon pour sceller les raccords filetes. Employer sculement un scelle-joint liquide ou en pate pour tuyanterie. L'emploi de scelle-joints Loctite a base de polyacrylique ou d'acrylique n'est pas recommande. Le scelle-joint Loctite a base d'eau, tel que Vibra-Seal No. 503 est acceptable. (pp. 5, 7)

Safety Summary (continued)

WARNING

Type AP4 Positioners are suitable for a maximum supply pressure of 150 psig (1034 kPa). Do not exceed maximum recommended cylinder or actuator operating pressure. (pp. 7, 20)

AVERTISSEMENT

Le Positionneurs de Type AP4 sont prevus pour une pression maximum le l'alimentation en air de 150 psig (1034 kPa). Ne pas depasser le pression operationelle maximum recommandee pour le cylindre ou l'actuat. (pp. 7, 20)

CAUTION

If 1/4-inch NPT connections require tightening, do not exceed maximum torque of 60 inch-pounds. Do not use Teflon tape to seal threaded fittings. Use only liquid or paste pipe sealant. Use of Loctite sealants which are polyacrylate or acrylic diesters based, is not recommended. Water based Loctite sealant, such as Vibra-Seal No. 503, is acceptable. (p. 13)

ATTENTION

Se les connecteurs 1/4-inch NPT exigent un serrage, ne pas depasser le couple maximal de 60 pouces-livres. Ne pas employer de ruban Teflon pour rendre etanche les raccords filetes. Employer sculement un scelle-joint Loctite a base de polyacrylique ou d'acryliquie n'est pas recommande. Le scelle-joint Loctite a base d'eau tel que Vibra-Seal No. 503 is acceptable. (p. 13)

CAUTION

If 1/8-inch NPT connections require tightening, do not exceed maximum torque of 30 inch-pounds. Do not use Teflon tape to seal threaded fittings. Use only liquid or paste pipe sealant. Use of Loctite sealants, which are polyacrylate or acrylic diesters based, is not recommended. Water based Loctite sealant, such as Vibra-Seal No. 503, is acceptable. (p. 13)

ATTENTION

Se les connecteurs 1/8-inch NPT exigent un serrage, ne pas depasser le couple maximal de 30 pouces-livres. Ne pas employer de ruban Teflon pour rendre etanche les raccords filetes. Employer sculement un scelle-joint liquide ou en pate pour tuyanterie. L'emploi de scelle-joint Loctite a base de polyacrylique ou d'acrylique n'est pas recommande. Le scelle-joint Loctite a base d'eau, tel que Vibra-Seal 503, is acceptable. (p. 13)

Safety Summary (continued)

CAUTION

When arranged for reverse-acting applications, the unit could suffer serious damage if a bypass valve position were used and control signal pressure were introduced directly to the diaphragm actuator. The control pressure to the actuator during automatic operation is the opposite of control signal pressure from the control system to the Positioner. To effect a bypass arrangement, it is necessary to reverse the control signal pressure during manual operation of the Positioner. This is not practical for the small amount of time that the Positioner would be in manual during normal operation. (p. 17)

ATTENTION

Quand le systeme est amenage pour des applications en marche inversee, on risque de serieux degats si l'on emploie une position avec valve en "by-pass", et si l'on introduit directement la pression du signal de controle sur l'actionneur a diaphragme. La pression de controle agissant sur l'actionneur a cours de l'operation automatique est egale et de sense contrare par rapport a la pression de signal de controle que le systeme de control envoie au Positionneur. Pour emanger un "by-pass", il faudrait renverser la pression du signal de controle a cours de l'operation manuele du Positionneur. Ce n'est pas une solution pratique, considerant le temps tres cour de fonctionnement manuel du Positionneur au cours d'une operation normale. (p. 17)

WARNING

Permit only qualified personnel to maintain the system. Make certain maintenance personnel secure the system prior to starting maintenance procedures. Altering or removing components may affect the safe operation of the device. (p. 23)

AVERTISSEMENT

L'entretien du systeme doit etre effectue par un personnel qualifie. Il est imperatif que le personnel d'entretien s'assure de la securite d'operation du systeme avant d'entreprendre les procedures d'entretien du systeme, d'alterer sa configuration ou d'extraire des composants. (p. 23)

WARNING

Use solvent in a well-ventilated area. Avoid prolonged or repeated breathing of vapors. Avoid prolonged or repeated contact with skin. Do not use near open flame. (pp. 23, 24, 27)

AVERTISSEMENT

N'utiliser le dissolvant que dans un local bien ventile. Eviter l'inhalation prolongee ou repetee. Eviter le contact prolong ou repete avec la peau. Ne pas utiliser pres d'une flamme nue. (pp. 23, 24, 27)

Safety Summary (continued)

WARNING

Make certain Positioner is disconnected from supply pressure source or removed from service before attempting any repair or replacement procedures. (p. 24)

AVERTISSEMENT

Avant d'entreprendre de travaux de reparation ou de replacement, vou devez vou assurer que le Positionneur est coupe de la source d'alimentation en pression et debranche de la source de courant electrique. (p. 24)

CAUTION

Do not allow the lubricant to enter the orifice. (p. 24)

ATTENTION

Ne pas laisser le lubricant penetrer dans l'orifice (p. 24)

Introduction

The Characterizable Positioner (Type AP4) positions pneumatic single or double-acting actuators (rotary or linear motion) in response to an input signal from a pneumatic controlling device. The Positioner is usually located in the control loop between the controller and final control device (i.e., cylinder or diaphragm). A mechanical connection from the final control device to the position feedback cam establishes its actual position. When the controller calls for repositioning, the Positioner acts as a pneumatic relay, using an independent air supply, and directs the piston or valve to the new position. Three characterized curves are integral to a single cam: square root relation, linear relation, and square relation. The cam can be shaped to provide other desired relationships between input signal and final control element position.

Nomenclature

TYPE AP						CHARACTERIZABLE PNEUMATIC POSITIONER
4						Characterizable Positioner (pneumatic input)
	1					**Input Signal Range** 3-15 psig (20.7 - 103 kPa) 3-27 psig (20.7 - 186 kPa)
	2					
		1				**Stroke pan** 0.5 - 2.0 in. (12.7 - 50.8 mm), 45° rotary motion. 1.00 - 4.00 in. (25.4 - 101.6 mm), 90° rotary motion.
		2				
			0			**Valving** None *Integral shutoff and equalizing valve included.
			1			
				0		**Standard Design** (Enter 0 on all orders)
					0	**Drive Shaft** Tapered drive shaft (for radial arm)
					1	½ in. (12.7 mm) square end drive shaft

*For double-acting cylinder applications when manual override is necessary.

Specifications

TYPE AP4 SPECIFICATIONS

TABLE 1

Input Range	3-15 psig (20.7 - 103 kPa), 3-27 psig (20.7 - 186 kPa) 50% range suppression and/or zero elevation capability.
Standard Stroke Range	0.5 in. to 2.0 in. linear, rotary input 45° 1.0 in. to 4.0 in. linear, rotary input 90°
Gain	Adjustable to match actuator and load requirements (without changing springs)
Resolution	0.15% of span typical 0.3% of span maximum
Dead Band	0.15% of span typical 0.3% of span maximum
Hysteresis	0.2% of span typical 0.7% of span maximum
Repeatability	0.2% of span typical 0.5% of span maximum
Supply Pressure	20 to 150 psig (128 to 1034 kPa) Note: Minimum supply pressure should be 5 psi (34.4 kPa) above operating pressure required by actuator.
Supply Pressure Effect	
Single-Acting	0.05%/1.0 psi for ±10 psi change (0.05%/6.9 kPa for ±69 kPa change)
Double-Acting	Negligible
Capacity	25 scfm at 75 psig supply (0.71 m³/min. at 517 kPa) delivery and exhaust.
Air Consumption	
Single-Acting Diaphragm Actuators	Typical 0.12 scfm at 20 psig supply; 0.25 scfm max. at null (Typical 0.003 m³/min at 138 kPa supply; 0.007 m³/min. max. at null.)
Double-Acting Cylinders	Typical 0.6 scfm at 50 psig supply; 1.0 scfm max. at null. (Typical 0.017 m³/min at 345 kPa supply; 0.028 m³/min. max. at null.
Vibration Effect per SAMA Standard PMC 31.1-1980	Less than 2% error, 0-120 Hz, and accelerations to 2 G's.

Temperature Limits	
Operating Limits	—40°F to 180°F (—40°C to 82°C)*
Storage	—40°F to 200°F (—40°C to 93°C) *For operation below 40°F (4.4°C), dew point of the supply air must be 18°F (10°C) lower than the lowest expected operating temperature.
Mounting Position Effect	Negligible
Pneumatic Connections	1/4-in. NPT on supply, signal, and output connections, 1/8-in. NPT on pressure gages.
Enclosure Classification	NEMA 3R plus enclosure was subjected to corrosion test; continuous 5% salt fog atmosphere for 200 hours. No rust was evident.
Materials of Construction	Enclosure: VALOX* Relay Assembly: RYNITE**
Accessories	**Speed Control Orifices** — regulates time constant of Positioner and final control device. Orifices are installed directly into Positioner output ports (see Table 2). **Pressure Gages** — for reading input signal, supply and output pressures (see Table 3). **Positioner Mounting Kit** — for mounting the Positioner to direct- or reverse-acting actuators (see Figure 21). **Blank Cam** (Pt. No. 5327322-1) is available for adapting the Positioner to a particular application if cutting of the original cam is not desirable. **Bypass Valve** (Pt. No. 5326945-2) for single-acting diaphragm actuator applications. Enables the operator to use controller output signal to position the actuator directly when servicing the Positioner. See Figure 19. **Positioner Transmitter Conversion Kit** (Pt. No. 258345-1) provides the hardware for converting the Positioner to a position transmitter. Refer to Figure 20.

*Registered Trademark of General Electric Company
**Registered Trademark of E.I. duPont de Nemours and Co.

OPTIONAL SPEED CONTROL ORIFICES — **TABLE 2**

Orifice Size in. (mm)	Orifice Part No.
0.040 (1.02)	5327327-1
Blank (drill to suit)	5327327-2

PRESSURE GAGES — **TABLE 3**

Range psi (kPa)	Legend*	Part No.
0-30 (0-207)	Instrument	5326605-4
0-160 (0-1103)	Supply	5326605-5
0-160 (0-1103)	Output	5326605-6

*Instrument, Supply and Output gage used on single-acting devices. Two Output gages are used on double-acting devices. There are no provisions for mounting a Supply gage on a double-acting device.

Installation

Unpacking

1. Check for obvious damage to shipping carton.

2. Open carton and remove all loose packing.

3. Carefully remove Positioner from carton and inspect for any physical damage which may have occurred during shipping.

4. Remove four cover screws and Positioner cover and examine interior for any loose components such as nuts, screws, springs, etc. Check data on nameplate (located at right side of cam) for correct Type, and Signal Range.

5. If Positioner is suitable for the application and appears undamaged, replace cover and proceed with installation instructions.

Mounting

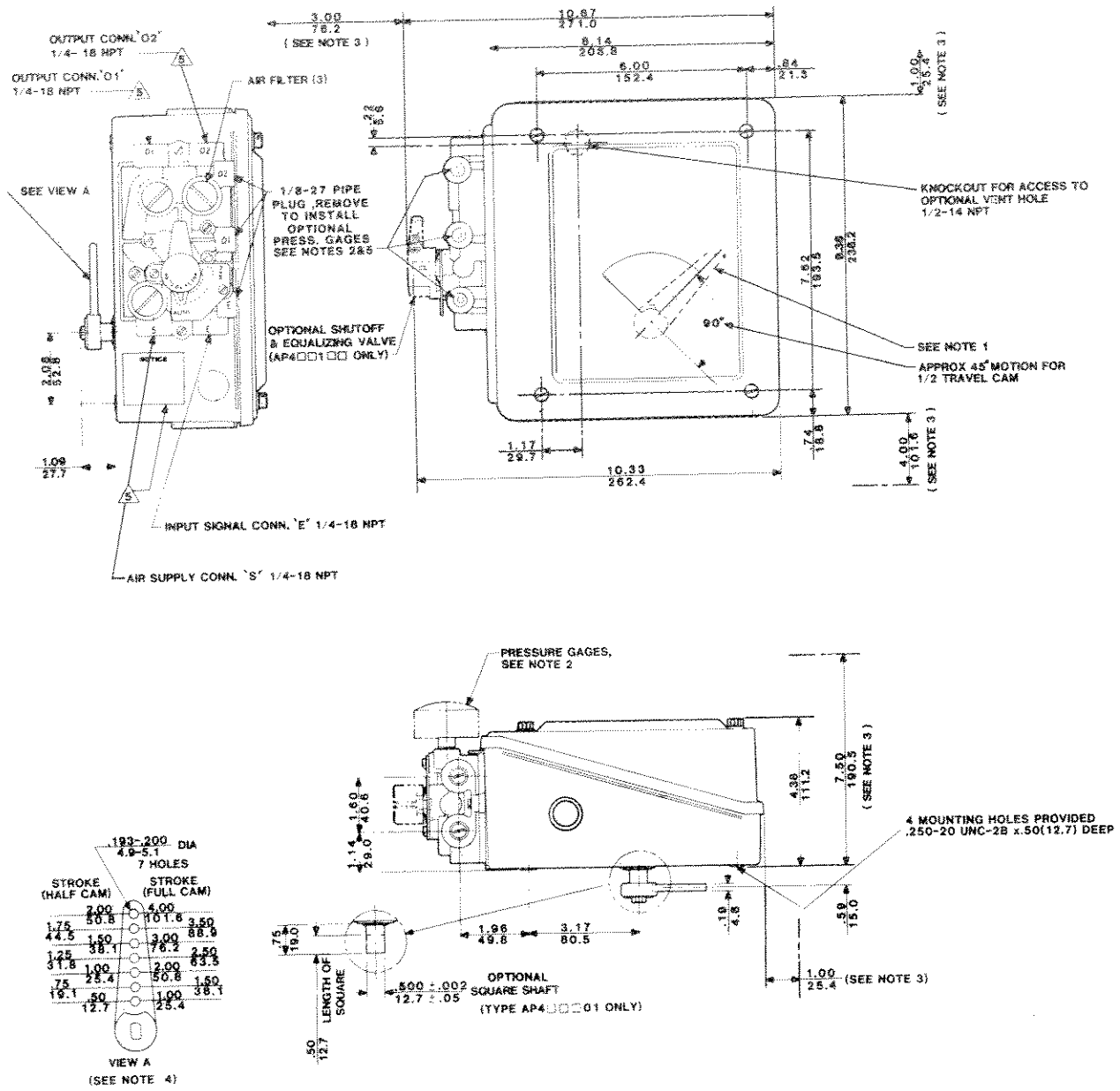
The Type AP4 Characterizable Pneumatic Positioner can be used with double-acting cylinders or single-acting diaphragm actuators. Mounting and external dimensions are shown in Figure 1.

CAUTION

Before mounting or installing Positioner, check nameplate data to make certain Positioner is suitable for application desired. DO NOT AT ANY TIME EXCEED THE RATINGS LISTED ON THE NAMEPLATE.

ATTENTION

Avant d'assembler ou d'installer le Positionneur verifiez les donnees figurant sur le plaque d'identification, pour vou assurer que ce modele de Positionneur correspond bien a l'application que vous envisagez. ON NE DOIT EN AUCUNE CIRCONSTANCE DEPASSER LES VALEURS NOMINALES FIGURANT SUR LA PLAQUE D'IDENFITICATION.



NOTES :
1. DRIVE ARM MAY BE ROTATED IN 45° INCREMENTS RELATIVE TO POSITIONING CAM.
2. PRESSURE GAGES ARE AVAILABLE ONLY AS AN ACCESSORY AND MUST BE INSTALLED BY THE CUSTOMER.
3. MINIMUM CLEARANCE FOR ADJUSTMENTS, INSPECTION, MAINTENANCE, AND OPERATION REQUIRED.
4. INPUT LEVER SHOWN IN VIEW A IS SUPPLIED WITH TYPE AP4□□□00 ONLY.
5. USE LIQUID OR PASTE PIPE SEALANT ON FITTINGS. (DO NOT USE TEFLON TAPE)
MAX. TORQUE
30 INCH-LB (3.39Nm) 1/8 NPT THDS
60 INCH-LB (6.78Nm) 1/4 NPT THDS

B8422

FIGURE 1 — Mounting and External Dimensions

CAUTION

Certain installation methods will not stroke the actuator or cylinder to a fail-safe condition if the controller fails to send a signal. Bailey strongly recommends that, for increased safety, an installation method be selected that will provide a fail-safe mode upon loss of controller signal.

ATTENTION

Certaines methodes d'installation n'assurent pas le retour de l'operateur d'alimentation de puissance a une condition garantissant automatiquement la securite, au cas ou le controleur aurait une defaillance et n'enverrait pas de signal. Dans l'interet de la securite, Bailey recommande avec insistance que la methode.

Double-Acting Cylinder Applications

When the Positioner is used with a double-acting cylinder, the piston rod is normally connected through suitable linkage to position a valve, damper or other regulating device. The position of the actuator or cylinder is normally tied back to the Positioner drive arm through a drive rod. Other tie back methods may be used depending on application. The drive arm is fixed to the positioner cam which is shaped to give a desired characteristic of actuator or cylinder position versus input demand control signal.

NOTE: Positioner mounting, pneumatic connections, and cam rotation must be such that an increasing control signal will extend (stretch) the range spring.

In any installation, the direction of piston travel for a given signal change can be reversed by using the opposite side of the cam and reversing the 01 and 02 output connections.

Figure 2 shows a typical Positioner installation for a double-acting cylinder. Pressure gages G1, G2, and G3 are optional and are not included unless specified when ordering Positioner.

CAUTION

When making 01 and 02 output connections, S or E input connections, or gage connections, do not use Teflon tape to seal threaded fittings. Use only liquid or paste pipe sealant. Use of Loctite sealants, which are polyacrylate or acrylic diesters based, is not recommended. Water based Loctite* sealant, such as Vibra-Seal No. 503, is acceptable.

ATTENTION

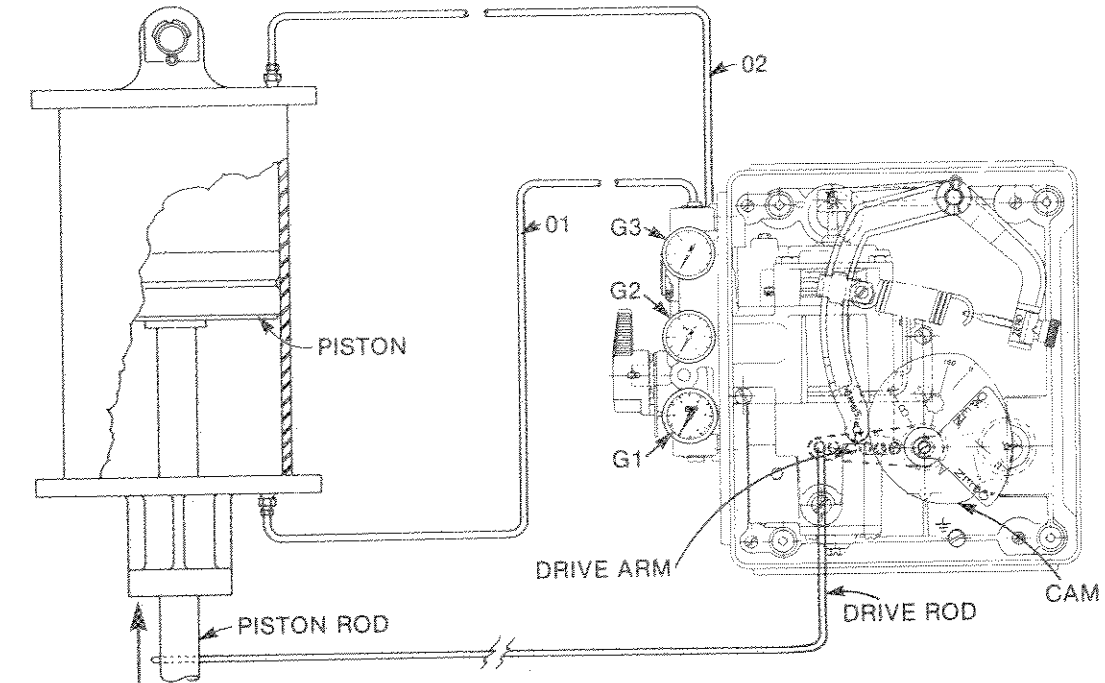
Pour les raccordements de debits 01 et 02, des entrees S ou E, ou des indicateurs, ne pas employer du ruban de teflon pour sceller les raccords filetes. Employer sculement un scelle-joint liquide ou en pate pour tuyanterie. L'emploi de scelle-joints Loctite a base de polyacrylique ou d'acrylique n'est pas recommande. Le scelle-joint Loctite a base d'eau, tel que Vibra-Seal No. 503, is acceptable.

*LOCTITE: Registered trademark of Loctite Corporation

Single-Acting Diaphragm or Spring-Loaded Actuator Applications

When the Positioner is applied to a single-acting actuator assembly, the valve stem is normally connected through suitable linkage to accurately position an inner valve in response to a control demand signal. The position of the valve stem (or inner valve) is normally tied back to the Positioner through a drive rod which is attached to the Positioner drive arm. The drive arm is fixed to the positioning cam which is shaped to give a desired characteristic of control valve position versus input demand control signal.

NOTE: Positioner mounting, pneumatic connections, and cam rotation must be such that an increasing control signal will extend (stretch) the range spring.



OPTIONAL PRESSURE GAGES

G1 - SIGNAL PRESSURE GAGE
G2 - OUTPUT PRESSURE GAGE
G3 - OUTPUT PRESSURE GAGE

NOTES:
FOR A DOWNWARD MOTION WITH INCREASING SIGNAL, USE BLACK SIDE OF CAM (COUNTER CLOCKWISE ROTATION) AND REVERSE 01 AND 02 CONNECTIONS.

IN ANY INSTALLATION, DIRECTION OF PISTON TRAVEL FOR A GIVEN SIGNAL CHANGE CAN BE REVERSED BY USING OPPOSITE SIDE OF CAM AND SWITCHING 01 AND 02 CONNECTIONS.

A8423

FIGURE 2 — Installation for Double-Acting Cylinder Applications.

CAUTION

When making 01 or 02 connections, S or E input connections, or gage connections, do not use Teflon tape to seal threaded fittings. Use only liquid or paste pipe sealant. Use of Loctite sealants, which are polyacrylate or acrylic diesters based is not recommended. Water based Loctite sealant, such as Vibra-Seal No. 503, is acceptable.

ATTENTION

Pour les raccordements de debits 01 et 02, des entrees S ou E, ou des indicateurs, ne pas employer du ruban de teflon pour sceller les raccords filetes. Employer sculement un scelle-joint liquide ou en pate pour tuyanterie. L'emploi de scelle-joint Loctite a base de polyacrylique ou d'acrylique n'est pas recommande. Le scelle-joint Loctite a base d'eau, tel que Vibra-Seal No. 503, est acceptable.

NOTE: Type AP4 Positioners may be used for positioning rotary-motion actuators. The cam shaft is connected directly to the rotary actuator for those applications.

Supply Pressure

Air supply pressure range is 20 to 150 psig (128 to 1034 kPa).

NOTE: Minimum supply pressure should be 5 psig (34.4 kPa) above operating pressure required by actuator.

WARNING

Type AP4 Positioners are suitable for a maximum supply pressure of 150 psig (1034 kPa). Do not exceed maximum recommended cylinder or actuator operating pressure.

AVERTISSEMENT

Les Postionneurs de Type AP4 sont prevus pour une pression maximum de l'alimentation en air de 150 psig (1034 kPa). Ne pas depasser la pression operationelle maximum recommandee pour le cylindre ou l'actuat.

NOTE: It is recommended that a filter or dripwell be installed in the air supply line to prevent improper operation of the Positioner due to entrained moisture or dirt.

In any installation, the direction of valve stem travel for a given signal change can be reversed by using the opposite side of the cam, plugging the output connection being used, and connecting tubing to the remaining output connection.

Figure 3 shows typical Positioner installations for a single-acting diaphragm actuator. Pressure gages G1, G2 and G3 are not included unless specified when ordering Positioner.

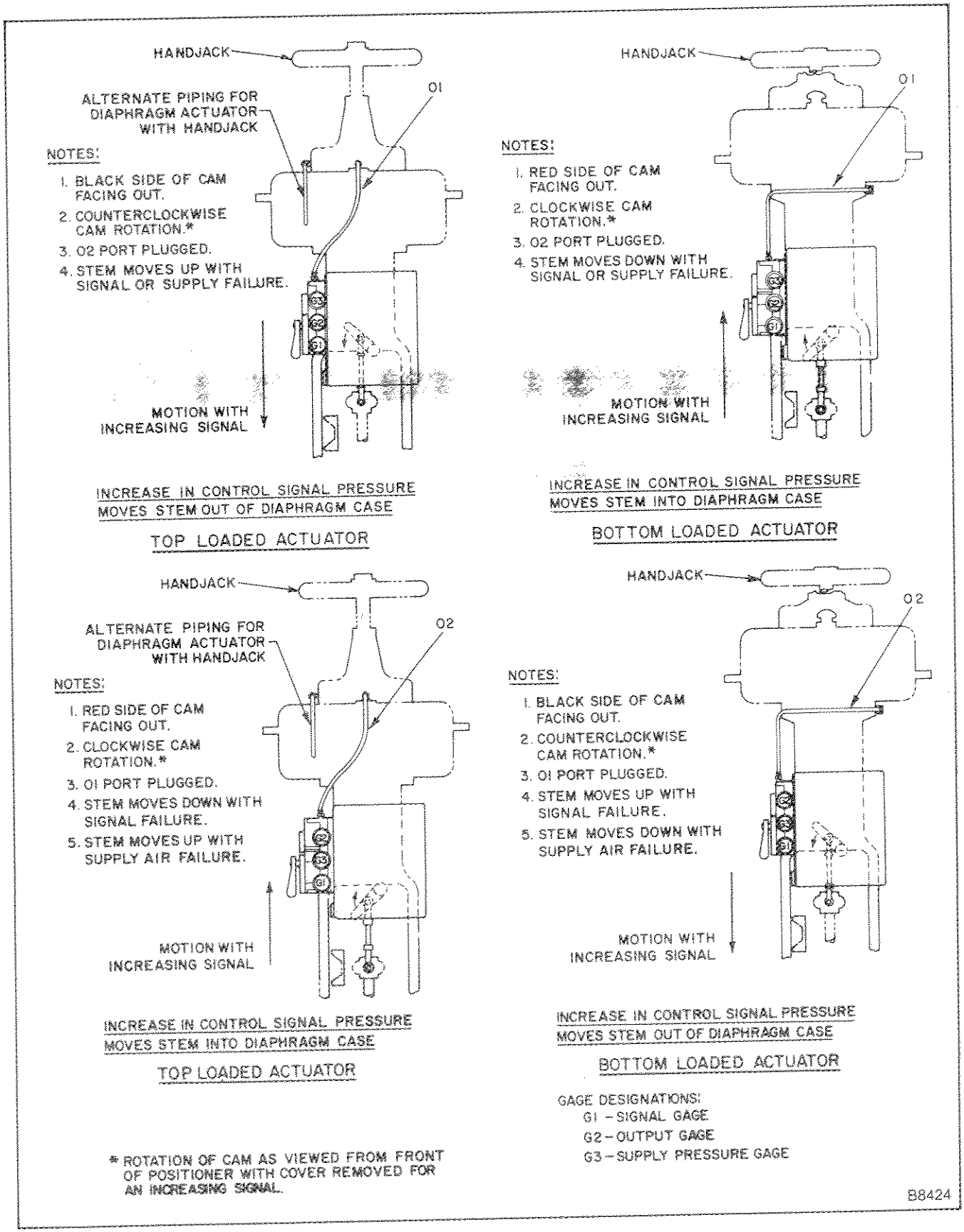


FIGURE 3 — Installation of Single-Acting Diaphragm Actuators

Operation

Characterized Cams

A positioning cam with segments A, B, and C (Figure 4) is furnished with each Positioner. As shipped, the B cam is assembled in place and the others are inactive. Selecting or shaping these cams allows the user to obtain a piston (or valve) position versus control signal characteristic that will produce a desired controlled medium versus control signal characteristic. An example is a desired flow rate of air, water, or steam through a valve for each control signal pressure applied to the Positioner.

POSITION CAM CHARACTERISTICS **TABLE 4**

Positioning Cam Any Stroke	Piston or Valve Position (P) vs. Control Signal (I)	Figure No.
A	Square Root ($I = \sqrt{P}$)	5
B	Straight Line ($I = P$)	6
C	Square ($I = P^2$)	7

The control characteristics for which the cams are shaped are listed in Table 4 and are shown in Figures 5, 6, and 7. The figures show a family of curves for each cam whose boundaries are established by a range adjustment. Table 5 lists control signal pressures of specific AP4 Positioners which corresponds to the signal range percent values in Figures 5, 6, and 7.

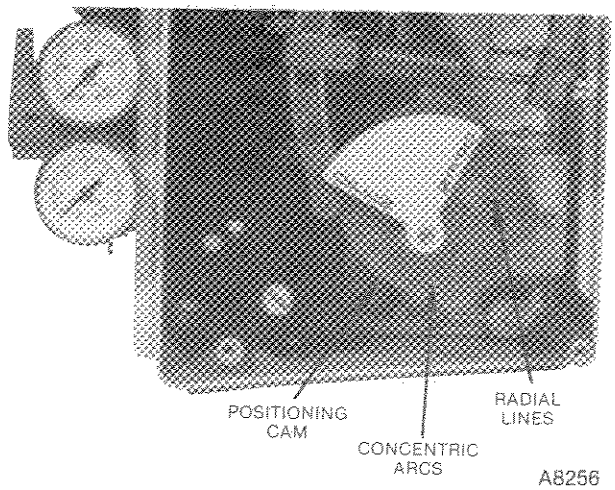


FIGURE 4 — Characterized Cam

CONVERSION TABLE FOR CONTROL SIGNAL PRESSURE **TABLE 5**

% Control Signal	Control System Ranges (psig)*	
	3-15	3-27
0	3.0	3.0
10	4.2	5.4
20	5.4	7.8
30	6.6	10.2
40	7.8	12.6
50	9.0	15.0
60	10.2	17.4
70	11.4	19.8
80	12.6	22.2
90	13.8	24.6
100	15.0	27.0

*For pressure values in kPa, multiply psig values by 6.895

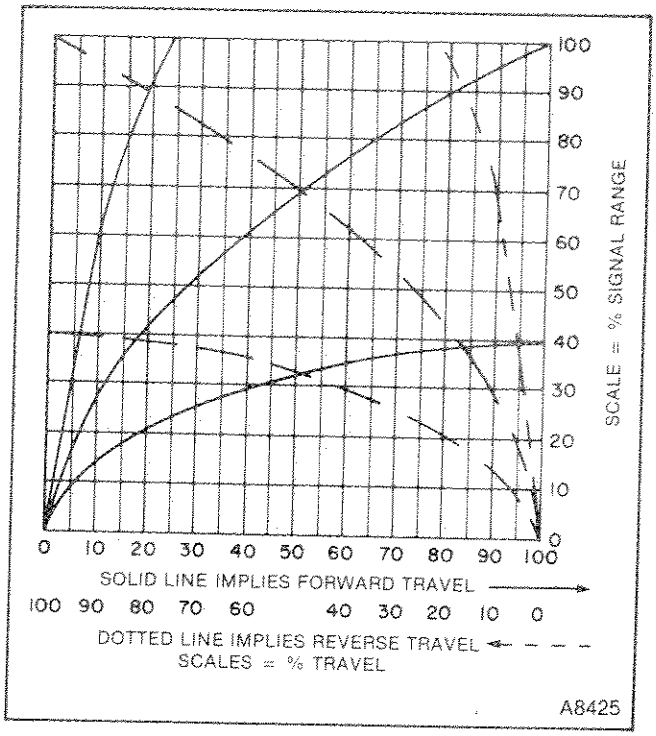


FIGURE 5 — Cam A, Square Root Relation

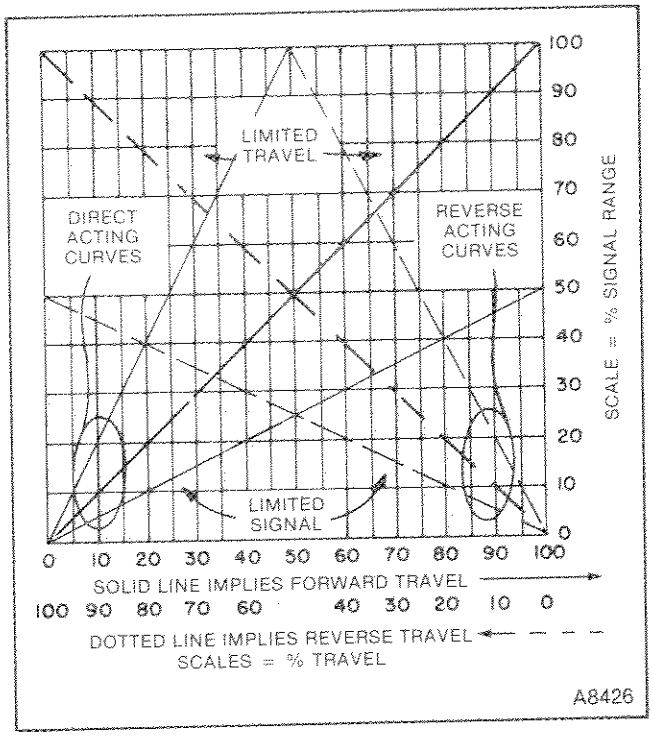


FIGURE 6 — Cam B, Linear Relation

In a system involving only a single actuator or cylinder, the B cam is probably satisfactory and should be tried first. However, one of the other cams may provide a more stable control over a wide range of operation within a given proportional band gain adjustment on the controller. Where the actuator or cylinder is part of a complex control system, the three standard cams A, B, and C provide a choice of control characteristics. The cam, in conjunction with a range adjustment, are likely to meet the control characteristic required for your system.

Cam Selection

Steps in selecting a standard cam for a particular application are:

1. With the B (straight line) cam in place, determine and plot the actual controlled medium versus piston (or valve) position characteristic by manually adjusting valve position and measuring the controlled medium (Figure 8).

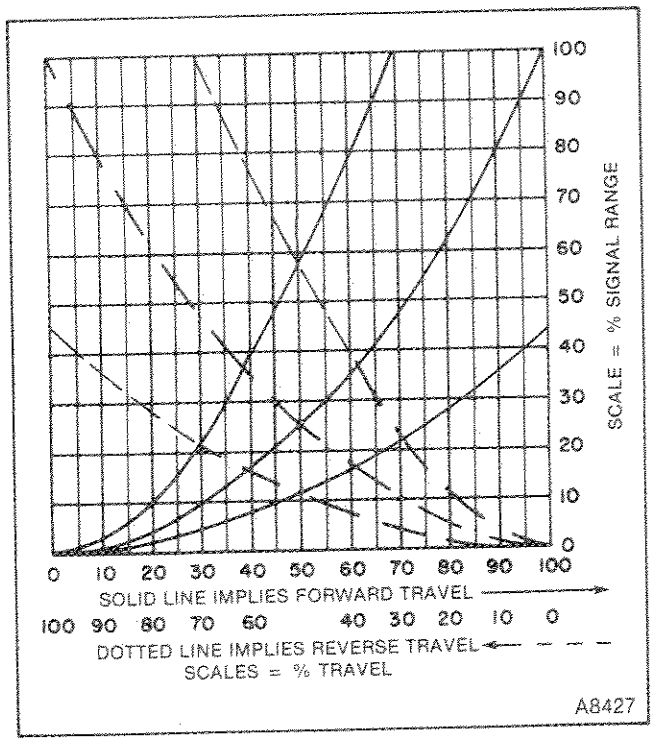


FIGURE 7 — Cam C, Square Relation

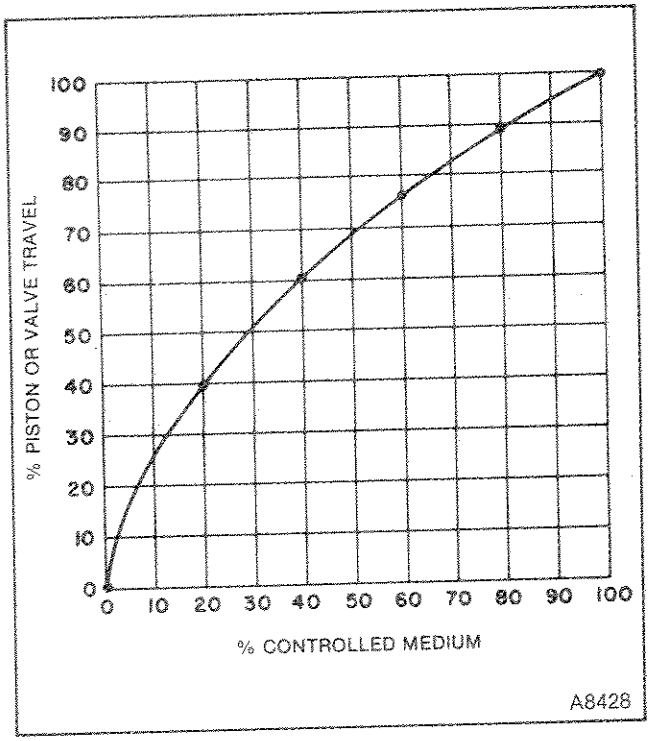


FIGURE 8 — Regulated Device Characteristics

2. Plot the exact controlled medium versus control signal pressure characteristic given or desired for the application.

This is usually a linear function (Figure 9).

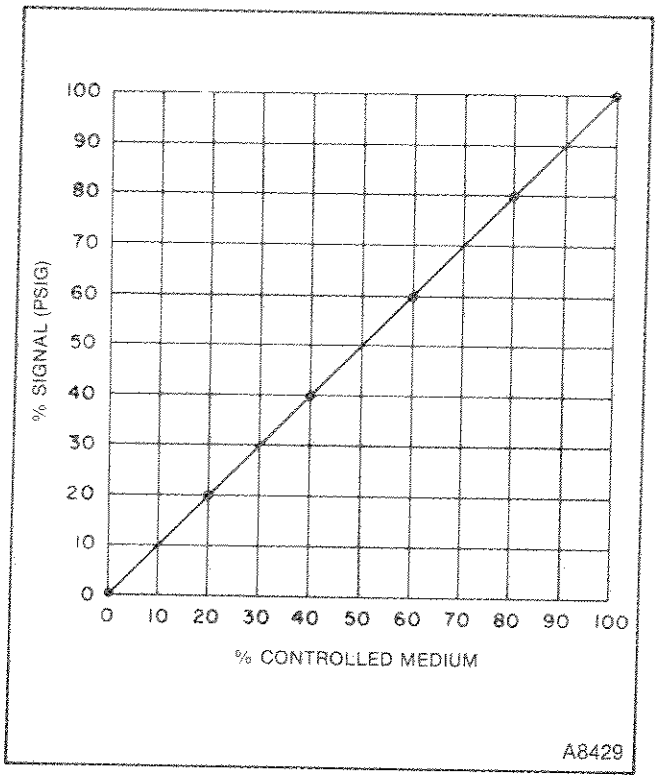


FIGURE 9 — Desired Control

NOTE: If angularity is introduced into the drive linkage, replot the controlled medium versus piston travel curves. In all cases, avoid overstroking the final control device.

3. Using values determined in Steps 1 and 2, plot a curve for the exact control signal pressure versus piston (or valve) characteristic that will produce the results of Figure 9 from a cylinder or actuator which performs as in Figure 8. In the examples shown, the required curve is a mirror image of the Step 1 curve taken about the Step 2 curve (Figure 10).

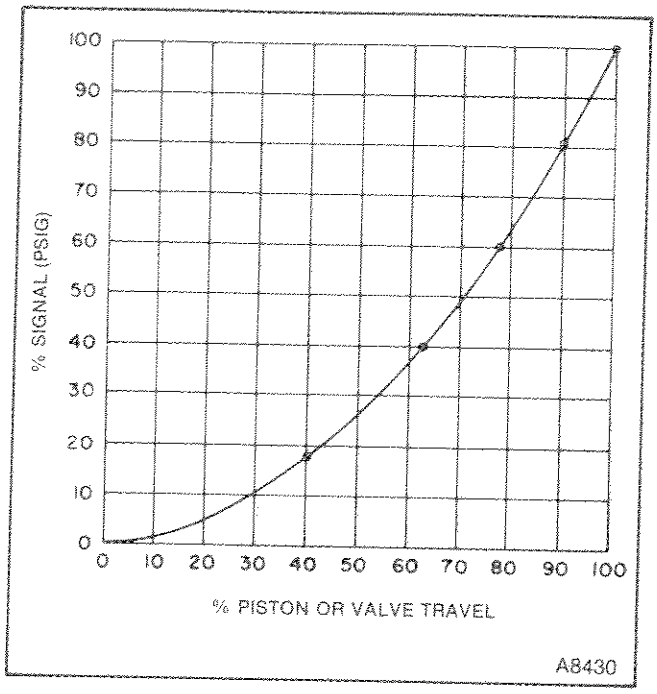


FIGURE 10 — Cam Characteristics

4. Compare the curve plotted in Step 3 with the cam curves shown in Figures 5, 6, and 7. Select a standard cam shape (in this case a C cam) whose characteristic most closely matches the control signal pressure versus piston (or valve) characteristics plotted in Step 3.

5. If necessary, adjust Positioner zero and range as outlined under "Zero and Range Adjustments" to make the control signal pressure versus piston (or valve) characteristic conform better to the curve plotted in Step 3.

6. If the required characteristic cannot be obtained using the above procedure, or if a more exact characteristic is required, alter the shape of a standard A, B, or C cam or cut a new cam from a blank as outlined under "CAM SHAPING METHOD."

Cam Shaping Method

To assist in the alteration process, a graph is inscribed on each cam. This graph consists of

radial lines and concentric arcs. The first and last radial lines mark the angles at which 0 and 100% of cam rotation occurs for control purposes; the radial lines in between are at 10% intervals. These lines are indexes of % piston (or valve) travel. The 11 concentric arcs on the cam correspond to actual control signal pressure values shown in Table 5 for the particular AP4 Positioner (3-15 psig unit or 3-27 psig unit) being used. Together, the radial lines and concentric arcs form a polar diagram on which a new cam shape (and characteristic) can be plotted.

NOTE: Before cutting any cam, make sure that shaping will involve REMOVEL OF CAM MATERIAL and not building up of cam material. For example, if the characteristic plotted lies between the A and B cams (Figure 5 and 6), cut the A cam.

1. Use the cam selected in Step 4 under "CAM SELECTION." Also have available a graph of control signal pressure versus piston (or valve) travel for the characteristic desired. (Such a graph may be derived from the cam characteristic curve developed in Step 3 under "CAM SELECTION"). Simply replace the % values on the vertical axis with the corresponding actual signal pressures from Table 5 for the Positioner (3-15 psig unit or 3-27 psig unit) being used.

2. Refer to Figure 11 for the method of transferring data from the graph to the cam. For each radial line on the cam (representing a % piston or valve travel), find the value of signal pressure on the graph which corresponds to that % piston or valve travel. Proceed along the radial line to the concentric arc which represents the signal pressure for the radial line's % piston or valve travel. Mark the cam at that point. Continue in this manner until all the radial lines are marked with a signal pressure point. (Example: in Figure 11, the graph calls for a signal pressure of 7.8 psig at the 60% travel position. On the 60% travel radial line of the cam, a mark is placed at concentric line 4, representing that pressure.)

3. Draw a curve through the points located in Step 2 above. This will be the desired cam shape.

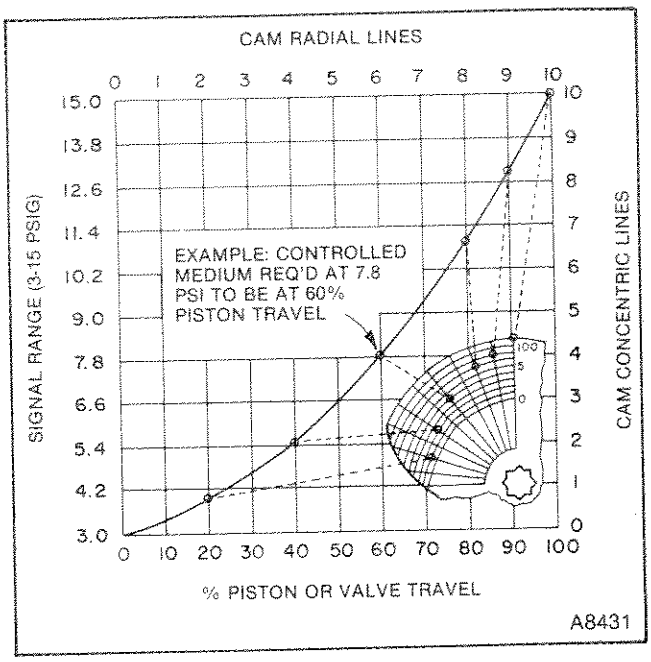


FIGURE 11 — Transferring Data from the Graph to the Cam

NOTE: If a cam shape has too steep a rise, the cam follower may become locked. A line printed on the cam indicates the maximum rise which should be cut into the cam. A cam with too steep a rise may be replaced with a cam with gentler rise if sufficient angularity is introduced into the drive linkage of the actuator or cylinder. Optional blank cam (Pt. No. 5327322-1) is available from Bailey Controls if alteration of the standard cam is not desired.

Placing in Service

Make the following adjustment checks to ensure correct operation of the valve actuator or cylinder assembly and the Positioner before placing in operation.

1. Make certain connecting linkage, brackets, and any mounting hardware are secure.

2. Move control drive or valve by hand from 0 to 100% of travel. Check position feedback drive arm (see Figure 2) to make sure you have full travel. If the drive arm binds, reposition the drive rod.

3. Make certain supply, input control signal, and output pressure connections are tight. Check for leakage, while under pressure, with soapsuds solution. Refer to Figure 1 for torque values.

CAUTION

If ¼-inch NPT connections required tightening, do not exceed maximum torque of 60 inch-pounds. Do not use Teflon tape to seal threaded fittings. Use only liquid or paste pipe sealant. Use of Loctite sealants, which are polyacrylate or acrylic diesters based, is not recommended. Water based Loctite sealant, such as Vibra-Seal No. 503, is acceptable.

ATTENTION

Si les connecteurs ¼-inch NPT exigent un serrage, ne pas depasser le couple maximal de 60 pouces-livres. Ne pas employer de ruban Teflon pour rendre etanche les raccords filetes. Employer sculement un scelle-joint liquide ou en pate pour tuyanterie. L'emploi de scelle-joint Loctite a base de polyacrylique ou d'acrylique n'est pas recommande. Le scelle-joint Loctite a base d'eau, tel que Vibra-Seal No. 503 est acceptable.

4. If optional pressure gages G1, G2, and G3 were furnished, make certain gages are installed in correct location for application (Figure 2 or 3) and all connections are tight. Refer to Figure 1 for torque values. Check for leakage, while under pressure, with soapsuds solution.

CAUTION

If 1/8-inch NPT connections require tightening, do not exceed maximum torque of 30 inch-pounds. Do not use Teflon tape to seal threaded fittings. Use only liquid or paste pipe sealant. Use of Loctite sealants, wich are polyacrylate or acrylic diesters based, is not recommended. Water based Loctite sealant, such as Vibra-Seal No. 503, is acceptable.

ATTENTION

Si les connecteurs 1/8-inch NPT exigent un serrage, ne pas depasser le couple maximal de 20 pouces-livres. Ne pas employer de ruban Teflon pour rendre etanche les raccords filetes. Employer sculement un scelle-joint liquide ou en pate pour tuyanterie. L'emploi de scelle-joint Loctite a base de polyacrylique ou d'acrylique n'est pas recommande. Le scelle-joint Loctite a base d'eau, tel que Vibra-Seal 503, est acceptable.

5. Perform procedures outlined under **CALIBRATION** to check output pressure level adjustment and to set zero and range adjustments for the required application prior to placing the Positioner in service.

NOTE: Orange flag visible through window in Positioner cover will show relative position (% open).

Functional Description

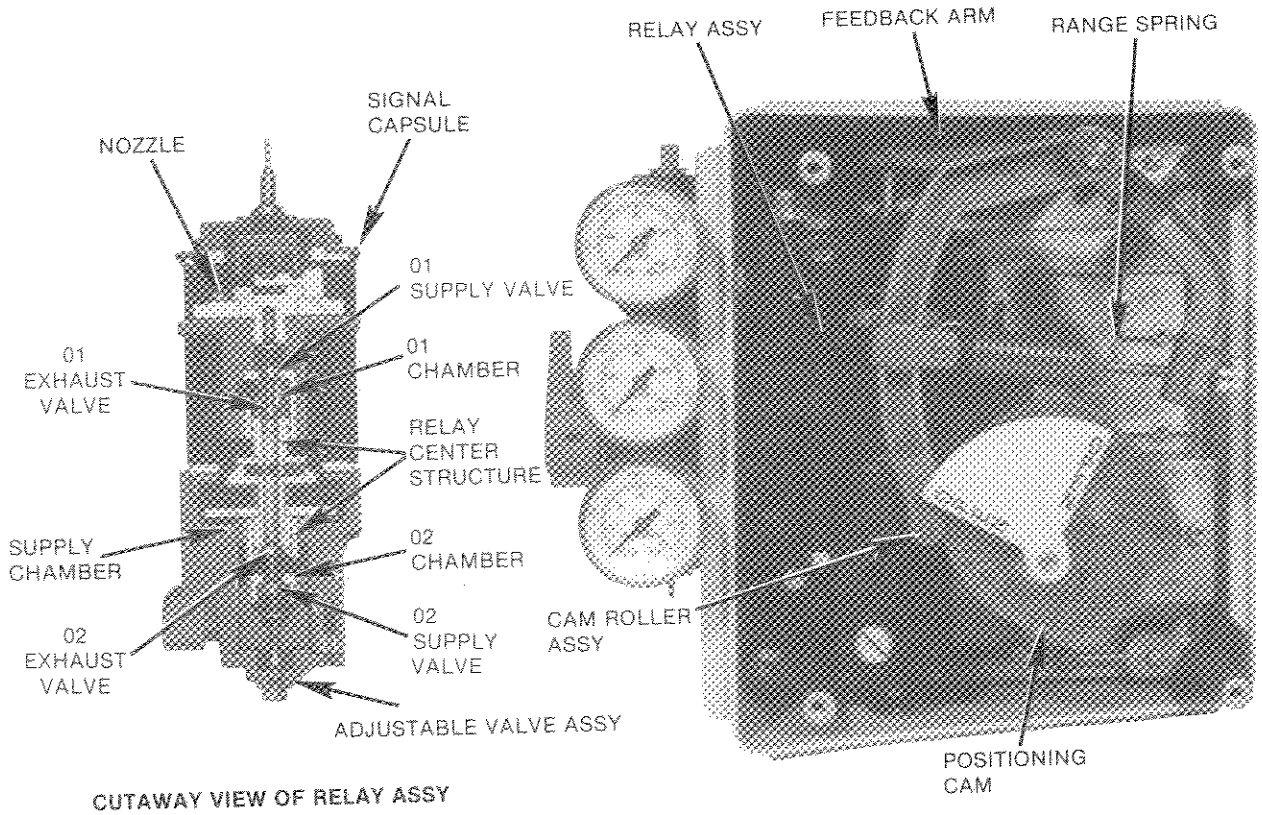


FIGURE 12 — Type AP4 Positioner with Cutaway View of Relay Assembly

Positioner Operation

Referring to Figure 12, a 3-15 psig or 3-27 psig control signal applied to the signal port of the Positioner acts on the signal capsule. An increasing control signal moves the signal capsule and vane assembly toward the nozzle, increasing back pressure in the nozzle chamber (not shown). The increased nozzle chamber back pressure acts against (opposes) the reference (supply) pressure, causing the relay center structure to move toward the 01 valve chamber and away from the 02 valve chamber. This action closes the 01 exhaust valve and opens the 01 supply valve, increasing the 01 output pressure to the final control device. The same action opens the 02 exhaust valve and closes the 02 supply valve, decreasing the 02 output pressure to the other side of the final control device (piston or diaphragm).

The pressure differential thus produced across the output ports displaces the final control device. As the final control device moves, its position is fed back to the positioning cam by direct connection between the final control device and the cam shaft or through a linkage arrangement. A range spring and feedback arm connect the cam follower to the signal capsule. Positioning cam rotation (caused by displacement of the final control device) extends the range spring, increasing the force on the signal capsule. When a force balance is reached between the force exerted by the range spring and the counterforce of the signal capsule (for a particular control signal value), the relay center structure returns to a neutral position, closing valves 01 and 02. The final control device is then in equilibrium, stopped at the position commanded by the control signal. A decreasing signal reverses the above sequence.

NOTE: The operation sequence for single-acting actuators is identical to that listed above, except that one output is eliminated through a valve adjustment.

The Positioner itself is normally located in the control loop (refer to Figure 13) between the controller and the final control device (actuator or cylinder).

Position Feedback

Actual final actuator or cylinder position is fed back to the Positioner for comparison with the position commanded by input control signal pressure. For a linear motion actuator or cylinder, the feedback mechanism consists of: 1) a drive rod which follows the motion of the actuator or cylinder; 2) an adjustable-length, swivel-ended connecting link which transmits motion of the drive rod to an adjustable drive arm on the Positioner; and 3) a camshaft and cam which are rotated through an angle by the drive arm. The primary function of the cam is to permit characterization of actuator or cylinder position versus input signal pressure.

A series of holes in the drive arm provides a choice of seven drive arm radius attachment points, accommodating nominal actuator or cylinder strokes from 0.5 to 4 inches. Refer to Table 6. One of the two cam configurations (45° or 90° rotation) are used, depending upon actuator or cylinder stroke.

Since the cam, camshaft and drive arm rotate as an assembly, cam motion is 90° or approximately 45°. The cam base circle is 1.3 inches and maximum rise is 0.9 inches. In each case a square-root cam A, a straight-line cam B, and a square-function cam C are stamped on one blank. The Positioner is shipped with the straight-line cam B in position (black side facing out). By flipping the cam over and reversing output connections 01 and 02, a reverse-acting application can be obtained.

DRIVE ARM HOLE POSITIONS vs. LENGTH OF STROKE **TABLE 6**

Drive Arm Hole Position from Cam Shaft	Length of Stroke (in.)	
	Full Stroke 90° Cam	Half Stroke 45° Cam
1	1	0.5
1	1.5	0.75
3	2	1
4	2.5	1.25
5	3	1.9
6	3.5	1.75
7	4	4

Each cam shape (A, B, or C) has its own 8-point center hole for mounting on the camshaft. By keeping the cam set at 0, the user can place the drive arm in any of eight 45° positions with respect to the cam. This provides flexibility in arranging that the midpoint of the cam will correspond to the midstroke of the final control device.

NOTE: For a rotary-motion device, the AP4 Positioner camshaft can be rotated by the device through direct coupling or through a timing belt, chain, or gearing.

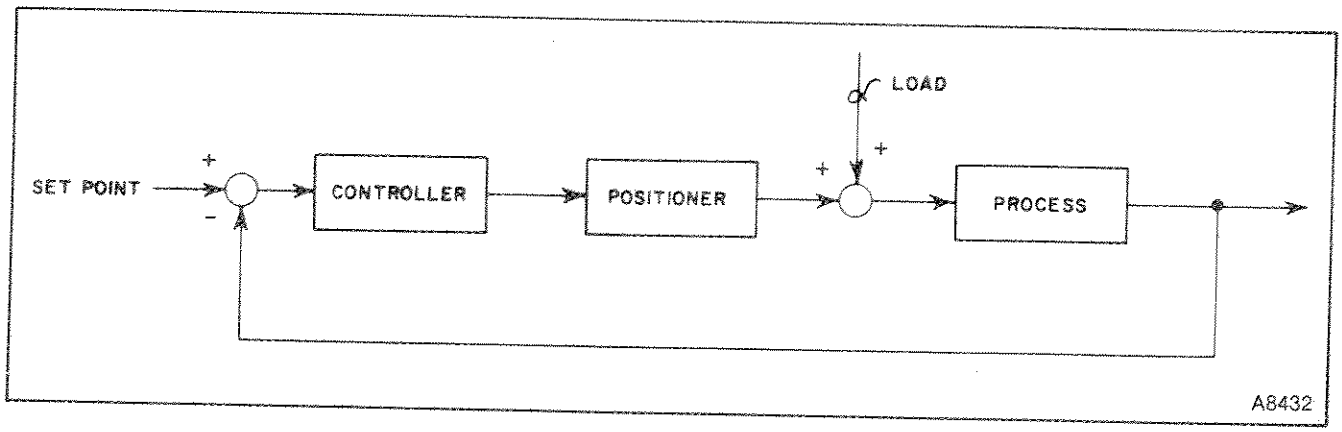


FIGURE 13 — Location of Type AP4 Positioner

Integral Shutoff and Equalizing Valve

Type AP4□□1□□

(Double-Acting Cylinder Applications)

If the Positioner is equipped with an integral shutoff and equalizing valve, the cylinder assembly may be manually or automatically operated as outlined below. By turning the valve handle to MAN, supply pressure to the cylinder is cut off and 01 and 02 are equalized, allowing manual repositioning of the piston.

Transfer from Manual to Automatic Operation

1. Valve handle should be in MAN position.

2. If manual operator does not lock drive cylinder in position:

a. The piston must be positioned from prior knowledge of piston position versus signal or piston may "jump" when transferred to automatic.

b. Depress valve handle and turn to AUTO position.

3. If manual operator locks drive cylinder in position:

a. Depress valve handle and turn to AUTO position. Drive cylinder will oppose manual operator if drive position and input signal do not correspond.

b. Manually operate drive until load on manual operator decreases. If output pressure gages are installed on Positioner, gage readings should equalize.

NOTE: If, in Step 3, it is desired that the drive stay in its initial position, the input signal must be adjusted to correspond with drive position as indicated by the load on manual operator, output pressure gages, or prior knowledge of position versus input signal.

Optional Bypass Valve

(Single-Acting Diaphragm Actuator Applications)

NOTE: External 3-way bypass valve referenced in the following procedures is available as an option from Bailey Controls.

Manual or automatic operation of a single-acting diaphragm actuator may be accomplished with an external 3-way bypass valve arrangement. Depending on the application, the Positioner may be adjusted for either direct or reverse-acting operation. When used for direct-acting applications, an increase in control signal pressure will cause an increase in output pressure to the actuator. When used for reverse-acting applications, an increase in control signal pressure will cause a decrease in output pressure to the actuator. Determine the application to which the Positioner is being applied and follow the correct procedure as outlined below.

Direct-Acting Applications

To change from remote automatic control to local manual control:

1. Turn bypass valve to its BYPASS position.

2. If Positioner is to be serviced, close supply valve.

To change from local manual control to remote automatic control:

1. Open supply valve.

2. Turn bypass valve to POSITIONER.

The final control valve may be positioned by signal pressure from the control system or, preferably, by manual operation of the Selector Station (if used) connected to the Positioner by the control pressure line.

Normally, the Positioner cannot be transferred from automatic to manual and vice versa without disturbing the control system. This is because the Positioner is usually calibrated to deliver control pressure to the diaphragm actuator which is different from control signal pressure received from the control system.

To manually operate the control valve by handjack:

1. Pick up valve position with handjack.

2. Close supply valve.

3. Position valve using handjack.

Reverse-Acting Applications

CAUTION

When arranged for reverse-acting applications, the unit could suffer serious damage if a by-pass valve position were used and control signal pressure were introduced directly to the diaphragm actuator. The control pressure to the actuator during automatic operation is the opposite of control signal pressure from the control system to the Positioner. To effect a bypass arrangement, it is necessary to reverse the control signal pressure during manual operation of the Positioner. This is not practical for the small amount of time that the Positioner would be on manual during normal operation.

ATTENTION

Quand le systeme est amenage pour des applications en marche inversee, on risque de serieux degats si l'on emploi une position avec valve en "by-pass" et si l'on introduit directement la pression du signal de controle sur l'actionneur a diaphragme. La pression de controle agissant sur l'actionneur a cours de l'operation automatique est egale et de sense contrare par rapport a la pression de signal de controle que le systeme de control envoie au Positionneur. Pour emanger un "by-pass," il faudrait renverser la pression du signal de controle a cours de l'operation manuelle de Positionneur. Ce n'est pas une solution pratique, considerant le temps tres court de fonctionnement manuel du Positionneur au cours d'une operation normale.

To change from automatic remote control to local manual control:

1. Pick up control valve position with handjack.
2. Close supply valve.
3. Pqsition valve using handjack.

Position Transmitter Applications

The Type AP4 Positioner may be used as a position transmitter, by generating a pneumatic signal which is a function of an input position. The same combinations of signal ranges and stroke spans are available as are offered in the Positioner application (i.e. 3 to 15 psig or 3 to 27 psig outputs from strokes from 0.5 to 4 inches).

The output signal may be made a square root, linear or square function of the input position through the use of the A, B or C portion of the cam, respectively. Other functions may be created through special shaping of the cam.

The AP4 may be made to function as a position transmitter by interconnecting the "E" input signal port with the "02" output port and tapping into this interconnection for the output signal. A plug is placed in the "01" output port. Position transmitter kit number 258345-1 (Figure 20) provides the necessary hardware.

A change in input (cam shaft position) causes a deflection of the range spring via the cam and linkage. The resulting unbalance of forces between the signal capsule and the range spring causes a change in the "02" output which is fed back to the signal capsule.

The signal capsule now acts as a feedback element by opposing the input force from the range spring. When the force from the "02" pressure in the signal capsule equals the new range spring force, the output will stabilize and will represent the desired function of the input position.

Position Transmitter Installation

Installation is similar to normal Positioner installation. The final control device should be coupled to the position transmitter's cam shaft so as to cause a 90° rotation of the shaft for full travel of the device (45° for AP4□1□0□). For a linear motion device (e.g. diaphragm actuators), the cam shaft is driven by the drive arm and a connecting link as the Positioner application. For a 90° rotation device, it may be desirable to couple the cam shaft directly to the final control device.

The "zero" position of the cam shaft can be adjusted in 45° increments by repositioning the cam on the shaft.

The direction of the transmitted signal can be reversed by reversing the cam. For example, with the red side of the cam facing out, clockwise rotation of the cam, viewed from the front of the unit, will cause an increasing signal. Reversing the cam

so that the black side faces out will result in a signal that decreases with clockwise rotation.

NOTE: The device to which the position transmitter is applied must supply power to operate the transmitter mechanism. Maximum torque to operate a 3 to 15 psig unit with a linear output is approximately 4½ inch-pounds. Torque may be as high as 25 inch-pounds for a square root characteristic and a 3 to 27 psig output with 50% suppression.

Calibrating the Position Transmitter

NOTE: Make certain that the Position Transmitter is set at minimum gain prior to making any adjustments.

Output Pressure Level Adjustment

1. Connect a pressure gage to the "01" output port or to the $^1/_8$-inch NPT gage port (G2 position in Figure 2).

2. Position the drive or actuator at mid-stroke.

3. Turn the adjustable valve screw, Figure 14, clockwise until the "01" pressure drops below the supply pressure. Turn the screw counterclockwise until the supply pressure is reached on the gage.

Turn the adjustable valve screw an additional one full turn counterclockwise.

Zero and Span Adjustments

The following description is based on a 3 to 15 psig output for 0 to 100% travel of the moving device.

1. Install an accurate pressure gage at the output connection or at the $^1/_8$-inch NPT gage G2 connection (Figure 2).

2. Turn off the air supply.

3. Slowly stroke the actuator or drive to its "zero" position. Adjust the linkage between the transmitter and the actuator or drive until the cam follower is at zero mark on the cam.

NOTE: In stroking the drive or actuator, be certain that the linkage is not overstrained due to misalignment. Correct if necessary.

4. Slowly stroke the drive or actuator to 100% of travel, taking care that linkage is free to move at all times. Adjust the pivot position in the drive arm (item 31, Figure 16) or other external linkage until the cam follower is at 100% of cam rotation (radial line marked 100 on the cam).

5. Repeat Steps 3 and 4 until the cam follower is at 0% cam when the actuator or drive is at 0% stroke and 100% cam when the drive or actuator is at 100% stroke.

6. Move the actuator or drive to 0% stroke position. If the output is not 3 psig, loosen the hex head setscrew in the knurled adjustment. Turn the knurled adjustment nut (while keeping the eyebolt from rotating) until a 3 psig output is achieved. Tighten the setscrew.

7. Move the actuator or drive to the 100% stroke position. If the output is not at 15 psig, loosen the .138-32 x 0.750 screw and move the spring clamp (Figure 14) along the cam follower arm until a 15 psig reading is obtained. Tighten the screw.

NOTE: Moving the spring clamp towards the pivot point provides a longer final control device stroke for a given signal change (i.e. increases the range of travel for the cam follower arm). Moving the spring clamp towards the cam roller assembly will result in a shorter final control device stroke for a given signal change (i.e. decreases the range of travel for the cam follower arm).

Calibration

General

Calibration of the Type AP4 Characterizable Pneumatic Positioner consists of adjusting the linkage from the actuator or cylinder so that the positioning cam rotates through its full range for full travel of the piston or valve stem, and adjusting (or balancing) the output pressure level.

The following adjustments are performed with the Positioner mounted on the actuator or cylinder. These adjustments are specifically for checking the operation of the two units prior to adapting the Positioner to a particular application. Once these adjustments have been made, proceed to **Calibration Adjustments for Particular Applications.**

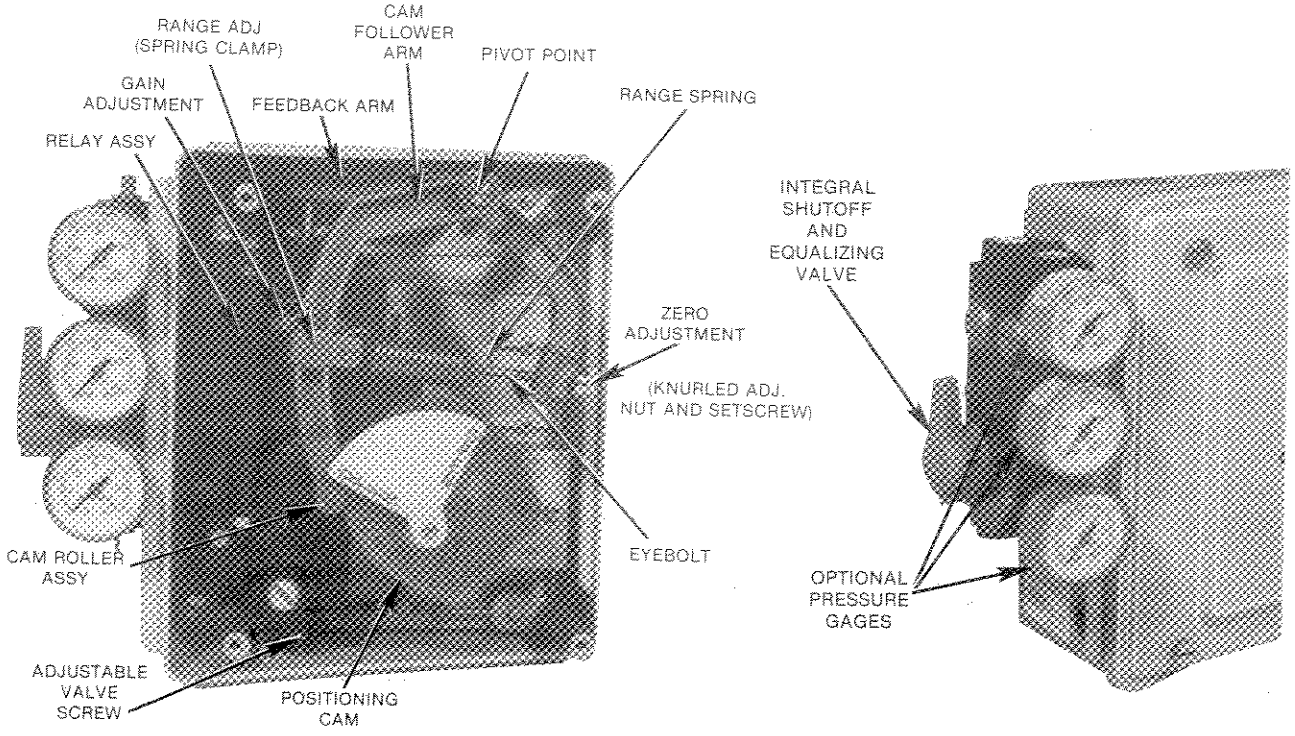
Output Pressure Level Adjustment

Double-Acting Cylinder Applications

If you must adjust Positioner output pressure level, refer to Figure 14 and perform the following procedure:

1. Use B (straight line) lobe of characterizing cam which is shipped in place in Positioner assembly.

NOTE: Make sure correct side of cam (red or black) is facing outward for application desired.



A8256
A8257

FIGURE 14 — Positioner Adjustments

2. Make supply air connection (20 to 150 psig) to port marked "S" on manifold (minimum supply pressure should be 5 psig above operating pressure required by actuator). Maintain this pressure during adjustments and after Positioner has been placed in service.

WARNING

Type AP4 Positioners are suitable for a maximum supply pressure of 150 psig (1034 kPa). Do not exceed maximum recommended cylinder or actuator operating pressure.

AVERTISSEMENT

Les positionneurs de Type AP4 sont prevus pour une pression maximum de l'alimentation en air de 150 psig (1034 kPa). Ne pas depasser la pression operationelle maximum recommande pour le cylindre ou l'actionneur.

3. If optional pressure gages are not included, connect customer supplied pressure gages to Positioner output ports 01 and 02 or to $^1/_8$-inch NPT gage ports (Figure 1).

4. Apply a mid-range signal (9 psig for 3-15 psig unit or 15 psig for 3-27 psig unit) with no load on cylinder.

NOTE: Make sure a mid-range signal is applied. Output pressure level cannot be adjusted if piston is against a travel stop.

5. Turn integral shutoff and equalizing valve (AP4□□1□□) to AUTO position.

6. Each output pressure gage should stabilize at approximately 2/3 of supply pressure (01 gage reading plus 02 gage reading should equal 4/3 of supply pressure).

7. If reading is not correct, remove caplug in bottom of enclosure and turn adjustable valve screw until reading is correct. Clockwise rotation decreases pressure, counterclockwise increases it. Use 3/8-inch socket through 3/4-inch hole, then replace caplug.

NOTE: If oscillation occurs, reduce gain by turning gain adjustment (Figure 14) to rotate nozzle in nozzle disc toward cam. Use screwdriver to engage teeth on nozzle disc. Turning nozzle disc toward manifold will increase gain. Higher gain can increase accuracy on large displacement cylinders or actuators.

Single-Acting Diaphragm Actuator Applications

If you must adjust Positioner output pressure level, refer to Figure 14 and perform the following procedure:

1. Use B (straight line) lobe of positioning cam which is shipped in place in Positioner assembly.

NOTE: Make sure correct side of cam (red or black) is facing outward for application desired.

2. Make supply air connection (20 to 150 psig) to port marked "S" on manifold (mininum supply pressure should be 5 psig above operating pressure required by actuator). Maintain this pressure during adjustments and after Positioner has been placed in service.

WARNING

Type AP4 Positioners are suitable for a maximum supply pressure of 150 psig (1034 kPa). Do not exceed maximum recommended cylinder or actuator operating pressure.

AVERTISSEMENT

Les positionneurs de Type AP4 sont prevus pour un pression maximum de l'alimentation en air de 150 psig (1034 kPa). Ne pas depasser la pression operationelle maximum pour l'actionneur.

3. If optional pressure gages are not included, connect customer supplied pressure gages to $^1/_8$-inch NPT gage ports in location shown in Figure 3 for application desired.

4. Apply mid-range signal (9 psig for 3-15 psig unit or 15 psig for 3-27 psig unit) with no load on cylinder.

NOTE: Make sure a mid-range signal is applied. Output pressure level cannot be adjusted if piston is against a travel stop.

5. If reading on supply gage G3 (Figure 3) does not equal supply pressure being applied, turn adjustable valve screw counterclockwise until supply pressure is obtained. If reading is at supply pressure, turn the screw clockwise to decrease pressure and then counterclockwise until full supply pressure is attained.

NOTE: Supply gage may drop momentarily if a large step change is applied. Make readings after pressure stabilizes.

6. Once supply pressure is obtained, turn adjustable valve screw one (1) full turn counterclockwise.

Zero and Range Adjustments
(Refer to Figure 14)

The range spring assembly applies a proportional feedback force to the input signal diaphragm assembly. A knurled, threaded adjuster applies initial tension on the range spring and provides a zero adjustment. The hex head setscrew in the knurled adjuster must be loosened to make the adjustment.

Range adjustment of the Positioner is obtained by repositioning a spring clamp along the cam follower arm. Moving the spring clamp toward the cam roller assembly results in a shorter final control device stroke for a given signal chance (i.e., decreases the range of travel for the cam follower arm). Moving the spring clamp toward the pivot point of the cam follower arm produces the opposite effect.

Double-Acting Cylinder Applications

The adjustment procedure below is based on a direct-acting application as shown in Figure 2. If the cylinder is being used for a reverse-acting application, note that the movements and positions will be opposite those listed below. Normally, the regulating device (a valve, damper, etc.) used in direct-acting applications will be in the CLOSED position when the piston is at the bottom of the cylinder and in the OPEN position when the piston is at the top of the cylinder. The words OPEN and CLOSED as used in the following procedure refer to these positions.

Single-Acting Diaphragm Actuator Applications

The following adjustment procedure is based on a direct-acting, top connected diaphragm actuator as shown in Figure 3. If the actuator is being used for a reverse-acting application, note that the movements and positions will be opposite those listed below. Normally, a control valve used in direct-acting applications will be in the CLOSED position when the valve stem has traveled out of the valve body to its fullest extent and in the OPEN position when the stem has traveled into the valve body to its fullest extent. The words OPEN and CLOSED as used below refer to these positions.

NOTE: The following procedure applies to both single and double-acting cylinder applications.

1. Disconnect supply air.

2. Set integral shut-off and equalizing valve to "MANUAL."

3. Position piston (or valve) to CLOSED position. If cam follower is not at zero mark on positioning cam, disconnect and adjust Positioner drive rod (or other connecting linkage) until the cam follower is on zero mark on cam. Reconnect drive rod or other connecting linkage.

4. Set input signal at minimum range value (3 psig for 3-15 psig unit or 3-27 psig unit). Piston (or valve) should remain in CLOSED position.

5. Connect supply air.

6. Set supply to 18-150 psi.

7. Set integral shut-off and equalizing valve to "AUTO."

8. If piston (or valve) begins to move from its CLOSED position when Step 4 is made, loosen

setscrew located in recessed hole of knurled adjustment nut and turn zero adjustment nut clockwise to increase range spring tension until piston (or valve) returns to its CLOSED position.

9. Increase input signal 0.5 psig above minimum range value (to 3.5 psig for 3-15 psig unit or 3-27 psig unit). If piston (or valve) does not begin to leave its CLOSED position immediately, turn zero adjustment nut counterclockwise until such movement occurs. Once this zero adjustment is completed, retighten setscrew to lock zero adjustment nut in place.

10. Return to minimum input signal (3 psig). Piston (or valve) should go to CLOSED position.

11. Set input signal at maximum range value (15 psig for 3-15 psig unit or 27 psig for 3-27 psig unit). If piston (or valve) does not move to its full OPEN position, loosen spring clamp on cam follower arm and slide spring clamp along cam follower arm until piston (or valve) reaches full OPEN position. After this adjustment, tighten spring clamp on cam follower arm.

12. Decrease input 0.5 psig below maximum range value (to 14.5 psig for 3-15 psig unit or 26.5 psig for 3-27 psig unit). If piston (or valve) does not begin to leave its full OPEN position immediately, change the range adjustment as outlined in Step 11 until such movement occurs.

13. If a range adjustment per Step 11 was necessary, recheck the zero adjustments outlined in Steps 4 through 10.

Calibration Adjustments for Particular Applications

The following Positioner adjustments may be used to improve the operation of the actuator or cylinder either by itself or in relation to other systems or parts of a multiple system.

Zero or Suppression Adjustment

The zero adjustment (Figure 14) can be used to set initial tension on the range spring so that the piston (or valve) will not begin to move from its minimum position when the Positioner receives a normal 3 psig minimum range signal, but rather will require a larger input signal (anywhere between 3 psig and 9 psig for a 3-15 psig unit or between 3 psig and 15 psig for a 3-27 psig unit) for motion to begin. This application of suppression is useful when two or more devices are to be operated in sequence, where the device is equipped with a minimum stop, or where the characteristics of the device which the actuator or cylinder is moving must be matched with those of another regulated device.

Range Adjustment

The range adjustment (Figure 14) affords a variation of actuator or cylinder motion for a given range of control signal pressure. For example, with any of the characterized cams described below, the range adjustment allows full piston (or valve) travel to occur with a signal pressure change as small as 50% of its full range. At the other extreme, the range adjustment (with the A cam) can be set to produce as little as 25% of the travel capability of the piston (or valve) over the full input signal pressure range. This flexibility in range adjustment is useful when the device being regulated is oversized, since the adjustment allows operation of the actuator or cylinder through its useful motion for the desired full change in control signal pressure. It is also useful in matching the signal versus position characteristics of the actuator or cylinder with the characteristics of related power devices in the same control system.

Speed Adjustment

When the system involves only a single actuator or cylinder, a high positioning speed is usually an advantage. However, in a complex control system, it is generally desirable to operate all power devices at the same speed in order to avoid interaction between units and consequent undesirable process conditions. If it is necessary to reduce the speed of operation, 0.040-inch (1.02 mm) speed control orifices (Pt. No. 5327327-1) are available as an option from Bailey Controls Co. These orifices are installed directly into the output ports (01 and 02) of the Positioner and have ¼-inch NPT ports for connecting plumbing from the actuator or cylinder. If these orifices are too small, they may be drilled out to obtain desired speed control. Blank orifices (Pt. No. 5327327-2) are also available.

Maintenance

Routine Service

WARNING

Permit only qualified personnel to maintain the system. Make certain maintenance personnel secure the system prior to starting maintenance procedures. Altering or removing components may affect the safe operation of the device.

AVERTISSEMENT

L'entretien du systeme doit etre effecture par un personnel qualifie. Il est imperatif que le personnel d'entretien s'assure de la securite d'operation du systeme avant d'entreprendre les procedures d'entretien du systeme, d'alterer sa configuration ou d'extraire des composants.

1. Once each year, check all air connections for leakage, while under pressure, with soapsuds solution.

2. Maintain a clean air supply (free of dirt, oil, or moisture) to ensure satisfactory operation of Positioner. If recommended filter is installed in supply line (refer to "Supply Pressure"), remove and clean if necessary.

WARNING

Use solvent in a well-ventilated area. Avoid prolonged or repeated breathing of vapors. Avoid prolonged or repeated contact with skin. Do not use near open flame.

AVERTISSEMENT

N'utiliser le dissolvant que dans un local bien ventile. Eviter l'inhalation prolongee ou repetee. Eviter le contact prolong ou repete avec la peau. Ne pas utiliser pres d'une flamme nue.

3. Whenever Positioner is out of service (or when required), remove Positioner output valves 01 and 02 as outlined under "TROUBLESHOOTING" and clean with gasoline and kerosene.

4. Periodically remove orifice and filter assembly (refer to Figure 15 for locations) and check orifice for deposits. If necessary, replace orifice and filter assembly.

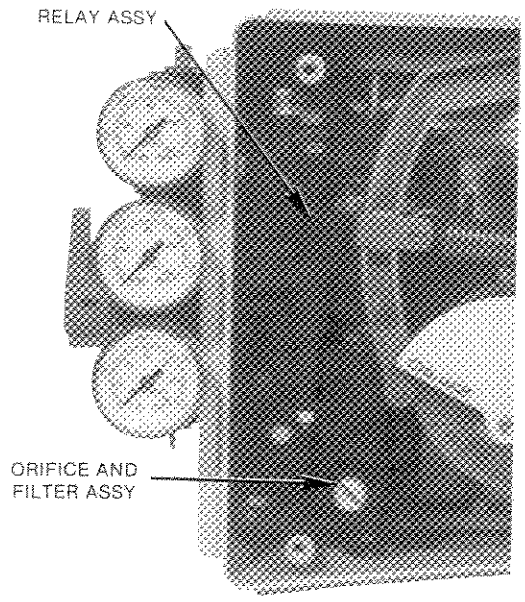


FIGURE 15 — Replacing Orifice and Filter Assembly

5. Periodically remove three filter holders (Figure 16, item 56) from manifold assembly (16) and replace stainless steel filters (10) for S, 01, and 02 ports. Apply small amount of O-ring lubricant (Dow Corning No. 4 or equivalent) to O-rings (27) before reassembling filter holders.

6. Once each year (or when required) check adjustment and calibration of Positioner and actuator or cylinder as outlined under **CALIBRATION.**

WARNING

Use solvent in a well-ventilated area. Avoid prolonged or repeated breathing of vapors. Avoid prolonged or repeated contact with skin. Do not use near open flame.

AVERTISSEMENT

N'utiliser le dissolvant que dans un local bien ventile. Eviter l'inhalation prolongee ou repetee. Eviter le contact prolong ou repete avec la peau. Ne pas utiliser pres d'une flamme nue.

7. If Positioner is equipped with optional integral shutoff and equalizing valve (AP4□□1□□), clean valve assembly and cavity each year (or when required) with gasoline or kerosene. Verify that supply pressure is shut off. Disassemble by removing two screws (Figure 16, item 47) through valve plate (19) and twisting valve spool out of cavity by grasping handle (18). Inspect raised, molded seal surface on valve spool. If necessary, replace valve by removing roll pin (46) and handle (18) from valve shaft and inserting shaft of new valve through valve plate (19), spring (20), and into handle (18) securing with roll pin (46). Lubricate new or existing valve spool with minimum amount of O-ring lubricant (Dow Corning No. 55M or equivalent) and reassemble into cavity. Replace screws (47).

Troubleshooting

If trouble occurs which is definitely traced to the Positioner, check supply pressure, input and output connections, and mechanical linkage adjustments before removing from service.

If no obvious defects are noted, refer to **Fault Correction Chart,** Table 7. Locate applicable heading for type of Positioner fault encountered. Procedures for checking or replacing various components and assemblies are described below.

WARNING

Make certain Positioner is disconnected from supply pressure source or removed from service before attempting any repair or replacement procedures.

AVERTISSEMENT

Avant d'entreprendre de travaux de reparation ou de replacement, vou devez vou assurer que le Positionneur est coupe de la source d'alimentation en pression et debranche de la source de courant electrique.

Replacing Orifice and Filter Assembly

1. Refer to Figure 15 and unscrew orifice and filter assembly.

CAUTION

Do not allow the lubricant to enter the orifice.

ATTENTION

Ne pas laisser le lubricant penetrer dans l'orifice.

2. Install new assembly (Bailey Pt. No. 5400040D1) after lubricating with a small amount of O-ring lubricant (Dow Corning No. 4 or equivalent).

Replacing Relay Assembly

1. Refer to Figure 16 and remove six screws (items 45, 54, and 55) from top of manifold assembly (16).

2. Lift off manifold assembly (16).

3. Remove indicator flag (41) and cam (2) from cam shaft (24).

4. Disconnect range spring (8) from cam follower arm (11).

NOTE: When the range spring is disconnected, items 3, 5, 6, 7, and 59 will be loose. Do not lose them.

5. Remove hairpin (42) from pivot shaft and lift off cam follow arm (11).

6. Remove second hairpin (42) and Teflon washer (44) above feedback arm (12).

7. Remove three screws (48) which fasten relay assembly (21) to backplate (1).

8. Carefully lift out relay assembly (21) and attached feedback arm (12).

9. Disassemble feedback arm (12) from relay assembly (21) by removing small hairpin (43) and roller pin (23).

10. To install new relay assembly, reverse Steps 1 through 9.

11. Recalibrate Positioner for correct application as outlined under **CALIBRATION.**

Replacing Output Valve 01

1. Refer to Figure 17 and remove four bolts (19).

2. Remove small screw (20) from vane assembly (24).

3. Carefully lift off signal housing assembly (1) and vane assembly (24).

4. With 1-inch open-end wrench, unscrew aluminum cap (12) from relay base (2). (Cap assembled at factory with adjustable sealant on threads.)

NOTE: Do not allow wrench to bear against nozzle projecting from nozzle disc (11) while unscrewing cap. Nozzle disc (11) will fall free when cap (12) comes out. Do not lose small rivet (13) set loosely in nozzle opening, or the O-rings.

FAULT CORRECTION CHART

TABLE 7

FAULT	PROBABLE	CORRECTIVE ACTION
Final drive element at one end of stroke and does not respond to input change	Obstruction in orifice leading to nozzle.	Check orifice as outlined under **REPLACING ORIFICE AND FILTER ASSEMBLY.**
	Relay (amplifier) section leaking internally.	Replace as outlined under **REPLACING RELAY ASSEMBLY.**
	Air lines in wrong ports.	Reverse lines connected to 01 and 02.
	Reversed cam rotation	Remove cam, turn over and reinstall.
Excessive air consumption (exhaust loud).	Leakage at joints of manifold assembly or relay assembly.	Remove manifold and check O-rings.
	Improper seating of output valves.	Remove valves as outlined under **REPLACING OUTPUT VALVE 01** and **REPLACING OUTPUT VALVE 02.** Clean valves and seats. Replace valves if necessary.

FAULT CORRECTION CHART

TABLE7

FAULT	PROBABLE	CORRECTIVE ACTION
Oscillation of final drive element.	Output pressure level too low at balance.	Reset output pressure level adjustment as outlined under **CALIBRATION.**
	Gain too high.	Adjust gain as described in **CALIBRATION.**
	Drive arm not securely attached to final drive element.	Tighten or correct linkage as necessary.
Slow response.	Output pressure level too high or too low.	Reset output pressure level adjustment as outlined under **CALIBRATION.**
	Output valves blocked.	Remove valves as outlined under **REPLACING OUTPUT VALVE 01** or **REPLACING OUTPUT VALVE 02.** Clean valves and seats. Replace valves if necessary.
	Relay (pneumatic amplifier) assembly not operating correctly.	Replace as outlined under **REPLACING RELAY ASSEMBLY.**
Final drive element at minimum travel stop and will not respond to input change.	Airlines in wrong ports or cam reversed.	Check and correct.
	Signal diaphragm leakage.	Replace diaphragm.
Uprange zero shift cannot be adjusted.	Signal diaphragm leakage.	Check and replace.
Full range cannot be obtained with adjustment.	Incorrect range spring.	Remove range spring and install correct spring for range required.
	Signal diaphragm leakage.	Check and replace.

5. Remove valve (10), valve spring (7), washer (8), and O-ring (9) from relay base. Examine O-ring and replace if necessary.

WARNING

Use solvent in a well ventilated area. Avoid prolonged or repeated breathing of vapors. Avoid prolonged or repeated contact with skin. Do not use near open flame.

AVERTISSEMENT

N'utiliser le dessolvant que dans un local bien ventile. Viter l'inhalation prolongee ou repetee. Eviter le contact prolongee ou repetee. Eviter le contact prolongee ou repete avec la peau. Ne pas utiliser pres d'une flamme nue.

6. Clean valve (10) using gasoline or kerosene and visually inspect for damage to seating surfaces. Examine valve seats inside of relay base (2) for dirt. Clean if necessary.

7. Apply minimum amount of O-ring lubricant (Dow Corning No. 4 or equivalent) to O-ring (9). Assemble valve spring (7), washer (8), and O-ring (9) on valve (10) and install this subassembly in relay base (2).

8. Remove concentric O-rings (4, 5, and 6) from top of relay base (2). Apply minimum amount of O-ring lubricant (Dow Corning No. 4 or equivalent) to O-rings (4, 5, and 6) and reinstall in grooves at top of relay base (2).

9. Apply adjustable seal (Loctite Sealant, such as Vibra-Seal No. 503 or other water based Loctite) to threads of cap (12). Install cap (12) through nozzle disc (11) into relay base (2). Torque to 40 inch-pounds.

NOTE: When reassembling relay, make sure small rivet (13) is seated in nozzle of nozzle disc (11). Align all components carefully. Torque small screw (20) in Step 2 to 9 inch-pounds and four bolts (19) in Step 1 to 30 inch-pounds.

Replacing Output Valve 02

1. Refer to Figure 17 and remove, as a unit, adjustable valve assembly (23) by removing three screws (21).

NOTE: After removing subassembly described in Step 1, visually check (or measure) the gap between bottom of valve and threaded end of captive adjustment screw in cover. This same approximate gap will be desired when reassembling adjustable valve assembly (23) and will assist in recalibrating the Positioner after final assembly is completed.

2. With a 3/8-inch wrench, back off captive adjustment screw in cover until adjustment valve clears slots in cover and falls free.

NOTE: The adjustment valve removed in Step 2 is detailed in Figure 18. It is available in assembled kit form from Bailey Controls, Pt. No. 258268A1.

3. Refer to Figure 18 to disassemble adjustment valve. Push slotted washer (2) up stem of valve (7) until washer (2) can be disengaged from valve seat (1) by turning 90°. Washer (2) will then fall free. With valve (7) still assembled, strip O-ring (3), washer (4), and spring (5) off stem of valve (7). Tilt valve (7) and gently remove from valve seat (1).

WARNING

Use solvent in a well ventilated area. Avoid prolonged or repeated contact with skin. Do not use near open flame.

AVERTISSEMENT

N'utiliser le dissolvent que dans un local bien ventile. Eviter l'inhalation prolongee ou repetee. Eviter le contact prolongee ou repete avec la peau. Ne pas utiliser pre d'une flamme nue.

4. Clean valve (7) using gasoline or kerosene and visually inspect for damage to seating surface. Examine seats engaged by valve (7) for dirt and clean if necessary.

5. Reassemble adjustment valve in reverse order of disassembly in Step 3. Examine O-ring (3) and replace if necessary. Apply minimum amount of O-ring lubricant (Dow Corning No. 4 or equivalent) to existing or new O-ring (3).

6. Examine O-ring (6) and replace if necessary. Apply minimum amount of O-ring lubricant (Dow Corning No. 4 or equivalent) to existing or new O-ring (6).

7. Refer to Figure 17. Reassemble adjustable valve assembly (23) as follows: Engage threads in adjustment valve with threads on captive adjustment screw in cover. With 3/8-inch wrench, turn captive adjustment screw to draw subassemblies together while guiding adjustment valve between slots in cover. Turn captive adjustment screw until gap (see **NOTE** following Step 1) is attained.

8. Reassemble adjustable valve assembly (23) to relay housing (3) with three screws (21). Make sure index mark on cover of adjustable valve assembly (23) is pointing to filter assembly (16) in relay housing (3).

Replacing Signal Diaphragm Assembly

1. Refer to Figure 17 and remove four bolts (19).

2. Remove small screw (20) from vane assembly (24).

3. Carefully lift off signal housing assembly (1).

4. Remove screw (25) and vane assembly (24).

5. Remove three screws and seal clamp from inside of signal housing assembly.

6. Remove signal diaphragm assembly by pushing down on stem assembly.

NOTE: The signal diaphragm assembly removed in Step 6 is available in assembled kit form from Bailey Controls, Pt. No. 258269A1.

7. To install new signal diaphragm assembly, reverse Steps 1 through 6. Before assembling new signal diaphragm assembly, remove and discard small screw and washer holding this assembly together for shipment and replace with screw removed in Step 4.

Replacing Range Spring

1. Refer to Figure 16 and disconnect range spring (8) from eyebolt (3) and spool (9), using needle nose pliers.

NOTE: When the range spring is disconnected, items 3, 5, 6, 7, and 59 will be loose. Do not lose them.

2. Select new range spring according to input signal range of Positioner as follows:

Range Spring Part No.	No. of Coils	Input Signal Range	Color Coded
5327330-2	14	3-15 psig	Red
5327330-3	11	3-27 psig	White

3. Install range spring.

4. Readjust zero and range adjustments as outlined under **CALIBRATION.**

Replacement Parts

Figure 16 is a parts drawing of the Type AP4 Characterizable Pneumatic Positioner. Figure 17 is a parts drawing of the Positioner Relay Assembly. Figure 19, 20 and 21 are optional equipment that can be ordered as accessories to the Positioner.

These figures will normally apply to the unit furnished. However, there may be individual differences in specific assemblies due to:

1. Design changes made since the printing of this instruction section.

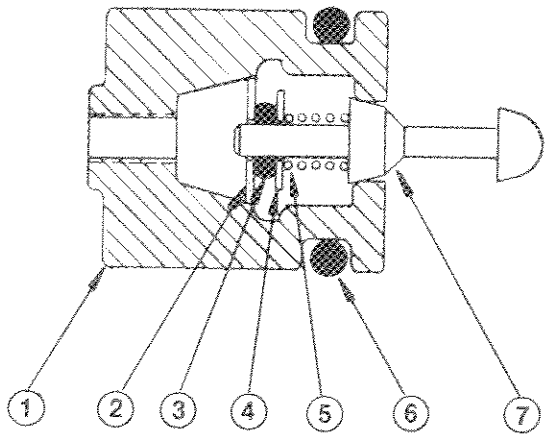
2. Special design of equipment furnished to make it suitable for special applications.

Therefore, when ordering individual parts, assure correct replacement by specifying on the order the complete nomenclature, code number, part number, and S.O. number of equipment for which parts are desired.

ITEM	PART NO.	NAME
1	5400046B1	BACKPLATE
2	SEE TABLE	CAM
3	197773A1	EYEBOLT
4	1963318A□	NAMEPLATE
5	197423A1	ADJ NUT
6	5400072A1	SUPPORT
7	5400073A1	KNIFE EDGE
8	SEE TABLE	RANGE SPRING
9	5400069A1	SPOOL
10	5400057A1	FILTER, 3 REQD
11	5400051A1	CAM FOLLOWER ARM
12	5400052A1	FEEDBACK ARM
13	5400060A1	VALVE, SHUTOFF
14	1951398A15	O-RING, 4 REQD
15	5400068A1	SPRING CLAMP
16	5400056A1	MANIFOLD ASSY
17	5400168A1	MANIFOLD GASKET
18	5400065A1	VALVE HANDLE, AP4□□10□, (SEE TABLE)
19	SEE TABLE	VALVE PLATE
20	5400067A1	SPRING WASHER, AP4□□10□, (SEE TABLE)
21	5400050A3	RELAY ASSEMBLY
22	5311425A1	CAM ROLLER ASSY
23	5400071A1	ROLLER PIN, 2 REQD
24	SEE TABLE	CAM SHAFT
25	19734A45	SMALL WASHER, 2 REQD
26	197777A50	RETAINING RING, 2 REQD
27	5311428A19	O-RING, 3 REQD
28	5400054A1	COVER
29	5400076B1	COVER GASKET
30	5400053A1	BOTTOM ENCLOSURE
31	5327445A1	DRIVE ARM, AP4□□□00, (SEE TABLE)
32	1951631A206	O-RING, 4 REQD
33	1951631A212	O-RING
34	1951631A214	O-RING
35	1951631A007	O-RING, 4 REQD
36	1951041A4	SOC HD PIPE PLUG, 4 REQD

ITEM	PART NO.	NAME
37	197227A1	SPECIAL HEX HD SEMS SCR, AP4□□□00, (SEE TABLE)
38	1951569A8	CAPLUG
39	5400075A1	VENT CAP
40	1945750A1	PULL PLUG, 4 REQD
41	5400085A1	INDICATOR
42	.265	TYPE 302 HAIRPIN, 2 REQD
43	.078	TYPE 302 HAIRPIN, 5 REQD
44	.385x.750x.031	PLAIN TEFLON WASHER, 2 REQD
45	.138-32x1.250L	PAN HD STN STL SEMS EXT, 2 REQD
46	.125x1.125L	STN STL ROLLPIN, AP4□□10□, (SEE TABLE)
47	.138-32x.312L	PAN HD STN STL SEMS EXT, 3 REQD
48	.190-32x.500L	PAN HD STN STL SEMS EXT, 3 REQD
49	197120A28	ELASTIC STOP NUT
50	.328 I.D. x.812 O.D. x.061 THK x.081 HGT	STN STL CONE WASHER
51	.190-32x.375	PAN HD STN STL SEMS EXT
52	.138-32x.750L	PAN HD CD PL STL SEMS EXT
53	.138-32x.438L	PAN HD STN STL SEMS EXT, 6 REQD
54	.138-32x1.750L	PAN HD STN STL SEMS EXT, 2 REQD
55	.190-32x.937L	CAPTIVE PAN STN STL SCR, 4 REQD
56	5400033A1	HOLDER, FILTER, 3 REQD
57	197675A1	WASHER
58	.190-32x.188L	HEX SOC HDLS STN STL OVAL PT SET SCR
59	199943	LABEL NOTICE
60	.190	LOCKWASHER
61	193214A1	BEARING, 2 REQD
62	1963652	LABEL, INDICATOR
63	1951569A13	BUTTON PLUG

FIGURE 16 — Item List

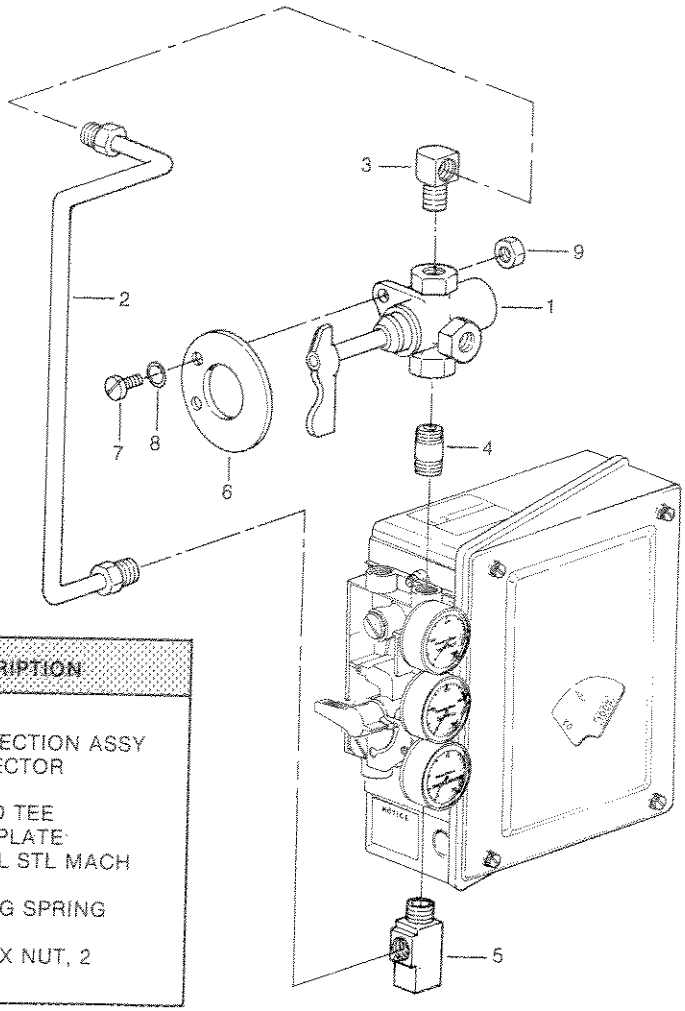


SPARE PARTS KIT
PART NO. 258268A1

ITEM	PART NO.	NAME
1	5400034A1	VALVE SEAT
2	5400035A1	WASHER
3	1951398A1	O-RING
4	19734A20	WASHER
5	5326599C1	SPRING
6	1951398A4	O-RING
7	5326580A1	VALVE

A9483

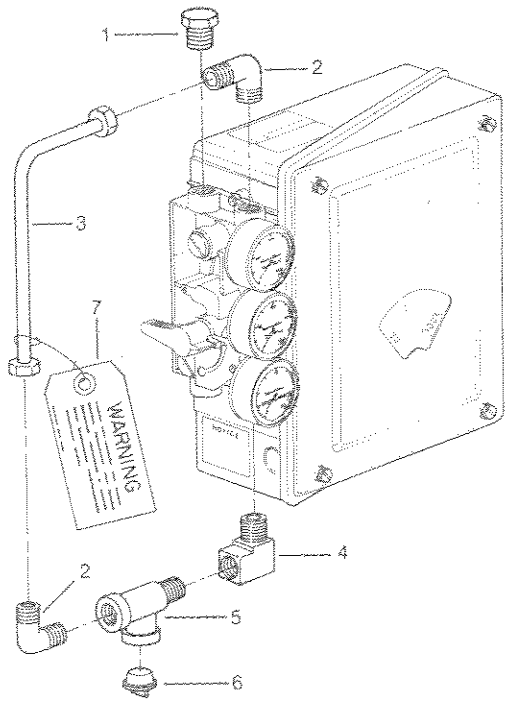
FIGURE 18 — Adjustable Valve Assembly



ITEM	PART NO.	DESCRIPTION
1	5327226A1	3-WAY VALVE
2	5326946A2	AIRLINE CONNECTION ASSY
3	195159A3	ELBOW CONNECTOR
4	195727A2	BRASS NIPPLE
5	195171A3	WEATHERHEAD TEE
6	1962833A1	DESIGNATION PLATE
7	.190-32x.375	PAN HD CAD PL STL MACH SCR, 2 REQD
8	NO. 10	CAD PL STL REG SPRING LKWASH
9	.190-32	CAD PL STL HEX NUT, 2 REQD

B9512

FIGURE 19 — Optional Bypass Valve Assembly for Single-Acting Diaphragm Actuators, Pt No. 5326945-2



ITEM	PART NO.	DESCRIPTION
1	¼-18 NPT	BRASS PIPE PLUG
2	4-4CB12-B	MALE ELBOW
3	5400170A1	AIRLINE
4	195590A1	STREET ELBOW
5	¼ MRO-B	STREET TEE
6	1945750A1	PULL PLUG
7	MP290-1078	WARNING TAG

A9513

FIGURE 20 — Optional Position Transmitter Conversion Kit, Pt. No. 258345-1.