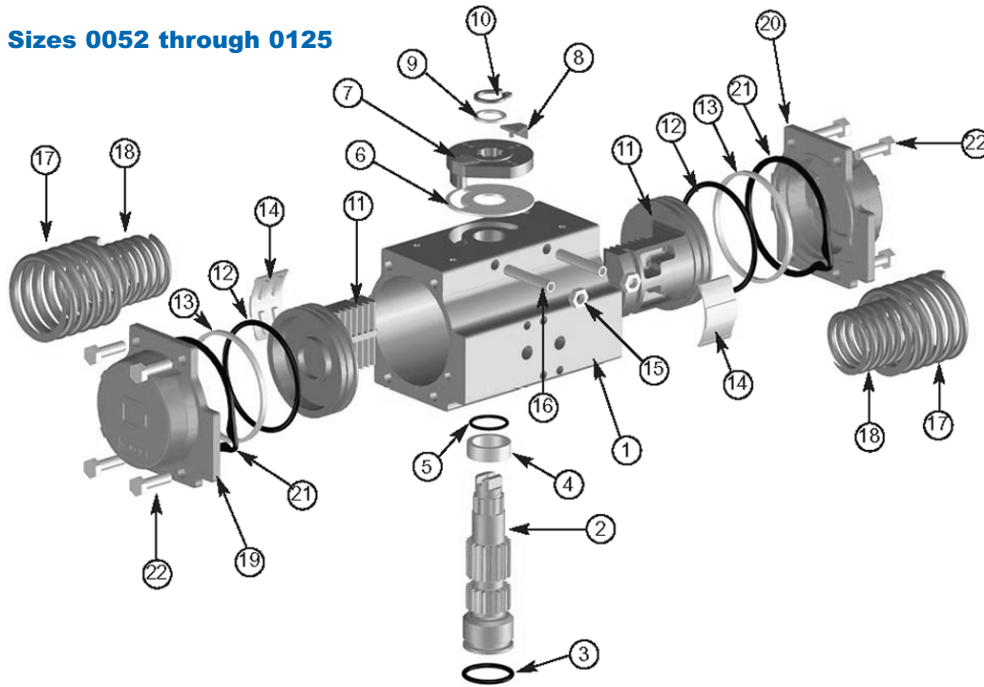


MAINTENANCE INSTRUCTIONS

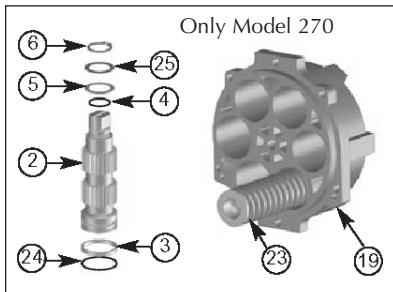
Direct Mount Pneumatic Actuators
 Double-Acting and Spring-Return
Installation, Service and Operation



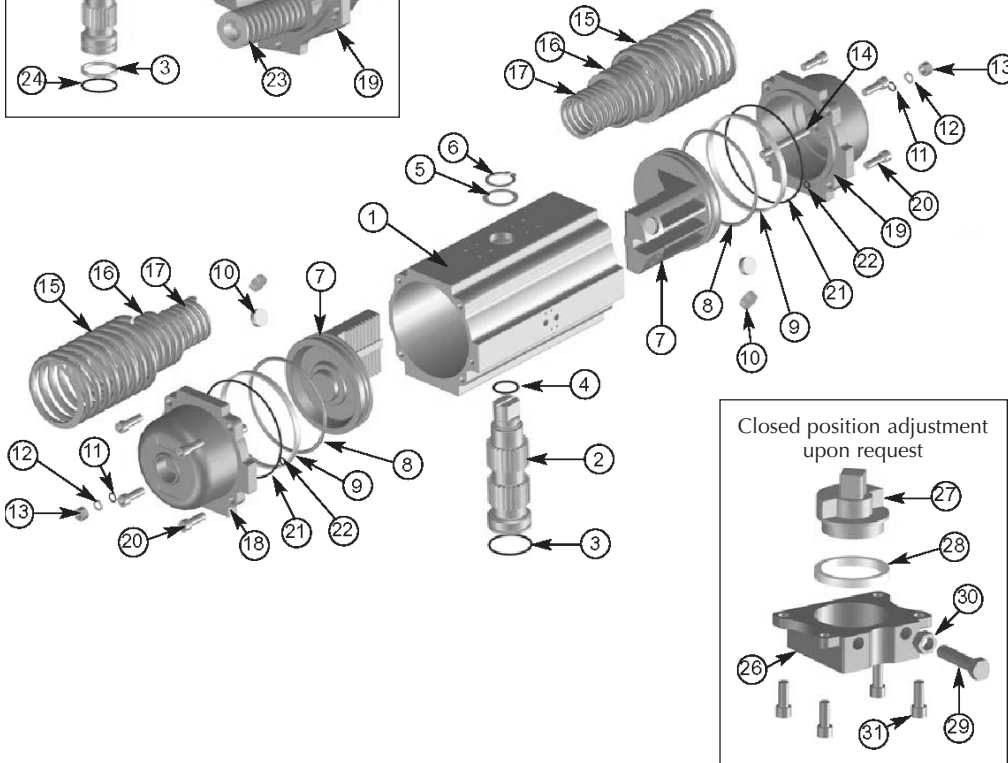
Sizes 0052 through 0125



COMPONENT LIST	
Item	Description
1	Housing
2	Pinion
3	Lower pinion O-ring
4	Pinion Spacer Ring
5	Top Pinion O-ring
6	Cam Spacer Ring
7	Cam
8	Position Indicator
9	Pinion Washer
10	Pinion Snap Ring
11	Piston
12	Piston O-ring
13	Piston Bushing
14	Rack Bushing
15	Stop Bolt Retaining Nut
16	Stop Bolt
17	Outer Spring
18	Internal Spring
19	Left End Cap
20	Right End Cap
21	End Cap Seals
22	End Cap Screw



Sizes 0160, 0200, and 0270



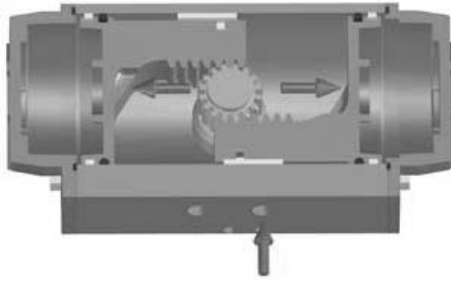
COMPONENT LIST	
Item	Description
1	Housing
2	Pinion
3	Lower Pinion O-ring
4	Top Pinion O-ring
5	Pinion Spacer Ring
6	Pinion Snap Ring
7	Piston
8	Piston O-ring
9	Piston Bushing
10	Rack Bushing
11	Stop Bolt Retaining Nut
12	Washer
13	Stop Bolt Retaining Nut
14	Stop Bolt
15	Outer Spring
16	Center Spring
17	Inner Spring
18	Left End Cap
19	Right End Cap
20	End Cap Screw
21	End Cap O-ring
22	End Cap Air Line O-ring
23	Precompressed Spring
24	Pinion Bushing
25	Pinion Washer
26	Plate
27	Coupling
28	Coupling Bushing
29	Stop Screw
30	Stop Screw Retaining Nut
31	Screws

OPERATION

PBM's Direct Mount Pneumatic Actuators are a double rack and pinion design. This design contains two racks with integral pistons horizontally opposed to each other within the actuator housing. The racks are engaged with a steel pinion gear on the torque shaft with full-length teeth. Actuators are Double-Acting (DA) or Spring-Return (SR) for 90° rotation. Standard actuators, when mounted on PBM valves, rotate clockwise to close the valve, and counter-clockwise to open the valve. Direction can be reversed if needed (see installation).

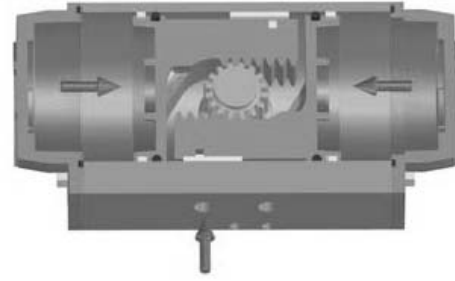
Double-Acting Actuators

Pressure is introduced through Port A, while venting through Port B, forcing the pistons away from each other and causing the torque shaft to rotate counter-clockwise. Pressure introduced through Port B, while venting through Port A, forces the pistons back toward the center, causing the torque shaft to rotate clockwise.



Port B Port A

Figure 1A



Port B Port A

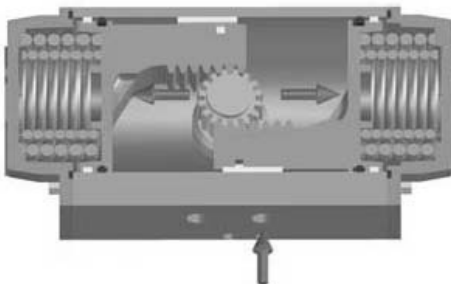
Figure 1B

When applying pressure to Port A and exhausting through Port B (Figure 1A), the pistons will move away from each other until a position adjustment stop screw stops motion. This screw is adjustable and precisely regulates rotation of the output shaft for the correct amount of travel. The pistons cause torque shaft to rotate counter-clockwise.

When applying pressure to Port B and exhausting through Port A (Figure 1B), the pistons move toward each other until a second position adjustment stop screw halts the motion. This screw is adjustable and precisely regulates the rotation of the torque shaft for the correct amount of travel. The pistons cause the torque shaft to rotate clockwise.

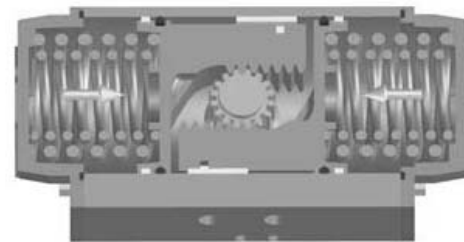
Spring-Return Actuators

Spring Return Actuators operate in the same manner as Double-Acting Actuators, except the pistons are forced toward each other by springs instead of pressurized medium. Actuators normally fail with clockwise rotation. For systems requiring fail counter-clockwise, follow procedures or converting to fail counter-clockwise.



Port B Port A

Figure 2A



Port B Port A

Figure 2B

When applying pressure to Port A and venting through Port B (Figure 2A), the pistons will move away from each other, rotate the torque shaft in a counter-clockwise direction, and compress the springs. The position adjustment stop screw halts the rotation.

When pressure is vented at Port A (Figure 2B), the springs will force the pistons back and rotate the torque shaft in a clockwise direction. On a Spring Return Actuator, Port B is a "breather port", needing no source of air pressure. A second position adjustment stop screw halts the rotation.

A. PBM Nomenclature

On the nameplate of each actuator there will be a PBM model number. The number will be PAVBL (2 or 4)53 (D or S)- (4 digit size designation). The 2 or 4 identify if the unit is for 60 psig (4 barg) air (the 2) or 80 psig (5.5 barg) air (the 4). For double acting actuators, this number will always be a 4, even if the actuator is sized for 60 psig air (4 barg). The D or S identify if the unit is double acting (the D) or spring return (the S). The final four digit number is the actuator size. For example, there are 10 sizes of actuators, 0052 being the smallest and 0270 being the largest.

B. Allowable Operating Parameters

Maximum air pressure - 120 psig (8 barg).

Supply - Clean dry air, free of water, oil, and particles. Alternate non-corrosive gases may be used in lieu of air. It is recommended that a filter be installed on the breather port of spring return actuators.

Allowable Actuator Temperature:

- Standard NBR seals, -4F (-20°C) to 185°F (85°C).
- Special high temperature Viton seals, -4°F (-20°C) to 302°F (150°C).
- Special low temperature seals, -40°F (-40°C) to 185°F (85°C).
- Lubrication - Lubricated at assembly for life, with proper air quality.

C. Operation

The actuator is assembled to rotate 90 degrees counter-clockwise when the right side air port is pressurized. Conversely, it will rotate 90 degrees counterclockwise when this pressure is released in a spring return unit or when this port is vented and the left side air port is pressurized in a double acting unit. On models 0200 and 0270 the air ports are aligned vertically. On these models the top most air port provides counter clockwise rotation.

These directions of rotation can be changed by removal of the pistons/racks and re-installing them with the rack gears on the opposite side of the pinion. On spring return units this modification may be necessary to change the fail position of the ball in the valve. Note that the spring return fail position on 2-way valves can also be changed by removing the actuator, turning the ball valve to the desired fail position, then re-installing the actuator. The valve will now close with CCW rotation rather than the normal CW rotation.

Stroke adjustment is provided in both positions for Models 0052 through 0125 and for the pistons/racks "extended" position for Models 0160 through 0270. An optional pistons/racks "in" stop is available for these larger sizes. This optional stop feature is not retrofittable, however, unless the pistons/racks are replaced. These stroke adjustments allow for a +5, -5 degree adjustment. It is important to check the stroke adjustments to ensure full flow and full shutoff are being obtained in the valve and to ensure flow impingement on the seats is not occurring.

Rugged components and factory lubrication help ensure a long trouble-free service life. Routine maintenance of PBM actuators consists primarily of maintaining the operating medium supply system. That is, (1) changing filter elements before they clog or restrict flow, and (2) ensuring the operating gas is dry.

Dirt and condensation are the most common causes of shortened service life. Dirt can enter the sealed actuator through the supply line or breather port. It is strongly recommended that an adequate sized filter with a 40 micron (or finer) element be installed on the inlet of the directional control valve and on the breather port of spring return actuators. Condensation, due to expansion and cooling of operating air, dilutes the lubricant and eventually results in gear corrosion. Dry supply air prolongs service life.

Misalignment between the valve and actuator can cause a shortened actuator service life. Misalignment can cause excessive side loads on bearings and gear teeth and lead to premature failure.

D. Setting the Position Stop Screws

1. Setting the Adjustment Stops on Sizes 0052 through 0125

Prerequisite

The actuator should be mounted on the valve.

Adjustment Direction

If the valve over-travels in one direction, the appropriate stop screw needs to be turned inward. If the valve under-travels in one direction, the appropriate stop screw needs to be turned outward.

Procedure

- a. When making an adjustment, the actuator should be positioned in the position not being adjusted. For example, if the closed stop is to be adjusted, the valve should be opened while making the adjustment. It is acceptable to have the actuator pressurized with air when making the adjustment (it is necessary on spring return units with a stop feature at the base of the pinion drive), but the actuator should never be in the position where the adjustment is being made.
- b. Position the actuator to the proper position.
- c. Loosen the nut on the Allen screw and turn the Allen screw in the proper direction, then tighten the nut to lock the screw.
- d. Cycle the actuator while noting whether enough or too much adjustment has been made. It is recommended that the valve position be checked by looking into the port of the valve when checking open position and by noting the position of the flats on the top of the valve's stem when checking closed position. If it is impractical to look into the valve ports, check alignment by looking at the position of the flats on the stem.

- e. Repeat as necessary until proper adjustment has been obtained.

2. Setting the Adjustment Stops on Sizes 0160 through 0270

Prerequisite

The actuator should be mounted on the valve.

Adjustment Direction

If the valve over-travels in one direction the stop screw needs to be turned inward. If the valve under-travels in one direction, the appropriate adjustment screw needs to be turned outward. All units have two adjustment screws on the end caps for adjustment when the unit is pressurized between the pistons (normally the open valve position adjustment). Some, but not all, units also have an adjustment screw below the pinion drive (normally the closed valve position adjustment).

Procedure

When making an adjustment, the actuator should be positioned in the position not being adjusted. For example, if the closed stop is to be adjusted, the valve should be opened while making the adjustment. It is acceptable to have the actuator pressurized with air when making the adjustment (it is necessary on spring return units), but the actuator should never be in the position where the adjustment is being made.

Setting the End Cap Screws

- a. Position the actuator to the proper position (normally the closed position).
- b. Loosen the nuts on the Allen screws and back out one of the two Allen screws about 2 turns.
- c. Turn the second Allen screw in the proper direction of needed adjustment then tighten the nut to lock the screw.
- d. Cycle the actuator while noting whether enough or too much adjustment has been made. It is recommended that the valve position be checked by looking into the port of the valve when checking open position and by noting the position of the flats on the top of the valve's stem when checking closed position. If it is impractical to look into the valve ports, check alignment by looking at the position of the flats on the stem.
- e. Repeat as necessary until proper adjustment has been obtained.
- f. After the position has been properly adjusted, pressurize between the piston to extend the piston against the screw just adjusted, then turn the second Allen screw in until it is tight against the piston, then tighten the nut to lock this second screw.

Setting the Adjusting Bolt at the Base of the Pinion Drive (if provided)

- a. Position the actuator to the proper position (normally the open position).
- b. Loosen the nut on the adjusting bolt.
- c. Turn the adjusting bolt in the proper direction of needed adjustment then tighten the nut to lock the adjusting bolt.
- d. Cycle the actuator while noting whether enough or too much adjustment has been made. It is recommended that the valve position be checked by looking into the port of the valve when checking open position and by noting the position of the flats on top of the valve's stem when checking closed position. If it is impractical to look into the valve ports, check alignment by looking at the position of the flats on the stem.
- e. Repeat as necessary until proper adjustment has been obtained.

E. Disassembly and Assembly of Sizes 0052 through 0125

1. Disassembly

CAUTION

- Spring return and double acting units are identical in appearance. If it is uncertain if the actuator has springs installed, follow the procedure for spring return units to ensure the end cap bolting is removed properly and that the springs are gradually extended.
- The unit being disassembled must be de-pressurized.

Remove End Caps from Spring Return Unit

- a. Loosen two diagonally opposed screws and back them off about 1/4th turn.
- b. Loosen the remaining two screws about 1/4th turn. The springs will push the end cap outward away from the housing. Repeat this process in an even manner until the springs gradually unload and the end cap comes off.
- c. Remove springs from the end of the housing.
- d. Repeat this process for the second end cap.

Remove End Caps from Double Acting Unit

- a. Loosen and remove the four screws on the unit and remove the end cap. The screws can be loosened and removed in any order.
- b. Repeat for the remaining end cap.

Remove Piston/Racks and Pinion

- a. Using snap ring pliers, remove the snap ring from the top of the pinion.
- b. Remove the pinion washer, the cam and the cam spacer ring

- c. Ensure the end caps have been removed, then turn the pinion to push the pistons and rack assemblies towards the ends of the housing. The piston gears will disengage from the pinion gears. Using a pair of pliers, pull the pistons out of the actuator. If they are not free to come out the pinion is not rotated enough.
- d. Push the pinion down into the housing and remove it from the bottom of the housing.

Preparations for Re-Assembly

Inspect bearings and seals for damage or excessive wear and replace as necessary with new parts or replace with new parts if the conditions appear questionable. If grease is contaminated with solids or water, the unit should be de-greased, cleaned and re-greased prior to assembly.

2. Assembly

- a. Install seals and bearings in their proper locations.
- b. Insert pinion up through the bottom of the housing, through the housing until it is seated on the bottom of the housing.
- c. Position the top of the pinion at a 45-degree angle with the axis of the housing.
- d. Slide the pistons/racks into the housing and engage the pinion gears.

Note

Normally, the left side piston/rack is positioned at the back of the housing when facing the air nozzles and the right side piston/rack is positioned on the near side of the housing. This will cause clockwise rotation of the pinion when looking down on the actuator when the springs cause the pinion to rotate and counter-clockwise rotation of the actuator when air causes the pinion to rotate. If it is desired to rotate the pinion counter-clockwise when the springs cause the pinion to rotate the locations of the two pistons/racks should be reversed.

- e. Push the pistons/racks as far into the actuator as possible.
- f. Measure the distance from both pistons to the end of the housing and note if the pinion is about 7 degrees off the axis of the housing. If both pistons are equal lengths from the end of the housing and the pinion is about 7 degrees off the axis of the housing they are installed properly. If none or only one of the two conditions exist, the racks are not properly engaged on the pinion (off a tooth). Remove pistons/racks and repeat if this occurs.
- g. Install the cam spacer ring, the cam and the pinion washer then install the snap ring.
- h. If the unit is spring return, install the springs in the housing. The table below indicated what springs should be installed for each spring set. The catalog should be consulted for torques at various air pressures for each spring set.
- i. Install the end caps with gaskets and tighten screws to bring the end caps tight against the housing. On spring return units the screws should be tightened in a staggered manner to keep the end cap parallel with the end of the housing.
- j. Cycle the unit with air to verify freedom of operation, direction of travel, alignment of the pinion, and check for possible leakage past the piston O-rings and through the housing seals.

**Models 0052 through 0125
Total Springs Installed for Each Spring Set Designation**

Spring Set Number	No. of Outer Springs	No. of Inner Springs
01	1	1
02	2	0
03	1	2
04	2	1
05	2	2

Standard Spring Sets in PBM Models 0052 through 0125

PBM Model Number	Spring Set No.	PBM Model Number	Spring Set No.
PAVBL253S- -0052	3 for 60 psig (4 barg) air	PAVBL453S- -0085	5 for 80 psig (5.5 barg) air
PAVBL453S- -0052	5 for 80 psig (5.5 barg) air	PAVBL253S- -0100	3 for 60 psig (4 barg) air
PAVBL253S- -0063	3 for 60 psig (4 barg) air	PAVBL453S- -0100	5 for 80 psig (5.5 barg) air
PAVBL453S- -0063	5 for 80 psig (5.5 barg) air	PAVBL253S- -0115	3 for 60 psig (4 barg) air
PAVBL253S- -0075	3 for 60 psig (4 barg) air	PAVBL453S- -0115	5 for 80 psig (5.5 barg) air
PAVBL453S- -0075	5 for 80 psig (5.5 barg) air	PAVBL253S- -0125	3 for 60 psig (4 barg) air
PAVBL253S- -0085	3 for 60 psig (4 barg) air	PAVBL453S- -0125	5 for 80 psig (5.5 barg) air

F. Disassembly and Assembly of Sizes 0160 through 0270

1. Disassembly

CAUTION

- Spring return and double acting units are identical in appearance. If it is uncertain if the actuator has springs installed, follow the procedure for spring return units to ensure the end cap bolting is removed properly and that the springs are gradually extended.
- The unit being disassembled must be de-pressurized.

Remove End Caps from Spring Return Unit

- a. Loosen two diagonally opposed screws on one end cap about 1/4th turn.
- b. Loosen the remaining two screws about 1/4th turn. The springs will push the end cap outward away from the housing. Repeat this process in an even manner until the springs gradually unload and the end cap comes off.
- c. Remove springs from the end of the housing.
- d. Repeat this process for the second end cap.

Remove End Caps from Double Acting Unit

- a. Loosen and remove the four screws on the unit and remove the end cap. The screws can be loosened and removed in any order.
- b. Repeat for the remaining end cap.

Remove Pistons/Racks and Pinion

- a. Using snap ring pliers, remove the snap ring from the top of the pinion.
- b. Remove the pinion spacer ring
- c. Ensure the end caps have been removed, then turn the pinion to push the pistons and rack assemblies towards the ends of the housing. The piston gears will disengage from the pinion gears. Using a pair of pliers, pull the pistons out of the actuator. If they are not free to come out the pinion is not rotated enough.
- d. If the actuator is provided with a stop adjustment at the bottom pinion drive unbolt and remove the adjustment plate.
- e. Push the pinion down into the housing and remove it from the bottom of the housing.

Preparations for Re-Assembly

Inspect bearings and seals for damage or excessive wear and replace as necessary with new parts or replace with new parts if the conditions appear questionable. If grease is contaminated with solids or water, the unit should be de-greased, cleaned and re-greased prior to assembly.

2. Assembly

- a. Install seals and bearings in their proper locations.
- b. Insert pinion up through the bottom of the housing, through the housing until it is seated on the bottom of the housing.
- c. Position the pinion at a 45-degree angle with the axis of the housing.
- d. Slide the pistons/racks with seals and bushings installed into the housing and engage the pinion gears.

Note

Normally, the left side piston/rack is positioned at the back of the housing when facing the air nozzles and the right side piston/rack is positioned on the near side of the housing. This will cause clockwise rotation of the pinion when looking down on the actuator when the springs cause the pinion to rotate and counter-clockwise rotation of the actuator when air causes the pinion to rotate. If it is desired to rotate the pinion counter-clockwise when the springs cause the pinion to rotate the locations of the two pistons/racks should be reversed.

- e. Push the pistons/racks as far into the actuator as possible.
- f. Measure the distance from both pistons to the end of the housing and note if the pinion is about 7 degrees off the axis of the housing. If both pistons are equal lengths from the end of the housing and the pinion is about 7 degrees off the axis of the housing they are installed properly. If none or only one of the two conditions exist, the racks are not properly engaged on the pinion (off a tooth). Remove pistons/racks and repeat if this occurs.
- g. Install the pinion spacer ring then install the snap ring. Install the stop adjustment plate at the pinion drive if it was provided.
- h. If the unit is spring return, install the springs in the housing. The table below indicated what springs should be installed for each spring set. For Model 0270, which has cartridge type springs, install the springs in as symmetric a manner as practical. The catalog should be consulted for torques at various air pressures for each spring set.
- i. Install the end caps with O-rings and air passage O-rings and tighten screws to bring the end caps tight against the housing. On spring return units the screws should be tightened in a staggered manner to keep the end cap parallel with the end of the housing.

Total Springs Installed for Each Spring Set Designation For Models 0160 and 0200

Spring Set Number	Number of Outer Springs	Number of Center Springs	Number of Inner Springs
01	0	2	0
02	2	0	0
03	1	2	0
04	2	0	2
05	2	2	0
06	2	2	2

Total Springs Installed for Each Spring Set Designation for Model 0270

Spring Set Number	Number of Springs in Side 1	Number of Springs in Side 2
01	2	3
02	3	3
03	3	4
04	4	4
05	4	5
06	5	5
07	5	6
08	6	6

Standard Spring Sets in PBM Models 0160, 0200, and 0270

PBM Model Number	Spring Set Number	Applicable Air Pressure
PAVBL253S- -0160	04	60 psig (4 barg)
PAVBL453S- -0160	05	80 psig (5.5 barg)
PAVBL253S- -0200	04	60 psig (4 barg)
PAVBL453S- -0200	06	80 psig (5.5 barg)
PAVBL253S- -0270	05	60 psig (4 barg)
PAVBL453S- -0270	08	80 psig (5.5 barg)

G. Troubleshooting

The following guidance is provided to help troubleshooting the source of problems that occasionally are encountered. Note that in a number of instances, problems that appear to be actuator malfunctions are associated with the solenoid valve or can be corrected with modifications to the air supply.

PROBLEM	POSSIBLE CAUSE	SOLUTION
Actuator cycles too slowly	Actuator too small for valve Actuator spring set not suitable for the air pressure Solenoid valve Cv too small Plugging of filter-mufflers on solenoid valve Spring broken in actuator Low air pressure Solenoid valve located remote from actuator	Install larger actuator Install higher number spring set Install solenoid valve with a larger Cv Clean/replace filter-mufflers Replace spring Repair air system or install larger actuator Install solenoid at actuator
Actuator cycles too fast	Solenoid valve Cv too large High air pressure	Add needle valves to solenoid valve exhaust port(s) Install air pressure regulator to lower pressure
Actuator has air blow by	Piston O-rings in actuator damaged O-rings in solenoid valve damaged	Replace piston O-rings in actuator Replace O-rings in solenoid valve
Actuator has excessive backlash	Worn rack and pinion gears or bearings in actuator	Replace worn parts
Actuator leaks air externally	Pinion or end cap seals damaged	Replace damaged seal

ACTUATOR REPAIR KITS

Repair kits consist of the following:

- End cap seals
- Piston seals
- Rack and piston bushings
- Snap ring
- Pinion O-rings
- Pinion bearings and washers
- Cam spacer ring (sizes 0052 through 0125)
- End cap adjustment seal O-rings (sizes 0160 through 0270)

To order a repair kit refer to the Actuator Repair Kit Table. These kits satisfy temperature requirements of -4°F through 185°F.

To order high temperature repair kits add the letter "H" after 1 in place of the dash. For example, a high temperature repair kit for a 0052 actuator would be PAVBL4 - - 1H - 0052.

Similarly, to order a low temperature seal kit, add the letter "L" after 1 in place of the dash.

Actuator	Repair Kit
PAVBL453S - - 0052 PAVBL453D - - 0052 PAVBL253S - - 0052	PAVBL4 - - 1 - - 0052
PAVBL453S - - 0063 PAVBL453D - - 0063 PAVBL253S - - 0063	PAVBL4 - - 1 - - 0063
PAVBL453S - - 0075 PAVBL453D - - 0075 PAVBL253S - - 0075	PAVBL4 - - 1 - - 0075
PAVBL453S - - 0085 PAVBL453D - - 0085 PAVBL253S - - 0085	PAVBL4 - - 1 - - 0085
PAVBL453S - - 0100 PAVBL453D - - 0100 PAVBL253S - - 0100	PAVBL4 - - 1 - - 0100
PAVBL453S - - 0115 PAVBL453D - - 0115 PAVBL253S - - 0115	PAVBL4 - - 1 - - 0115
PAVBL453S - - 0125 PAVBL453D - - 0125 PAVBL253S - - 0125	PAVBL4 - - 1 - - 0125
PAVBL453S - - 0160 PAVBL453D - - 0160 PAVBL253S - - 0160	PAVBL4 - - 1 - - 0160
PAVBL453S - - 0200 PAVBL453D - - 0200 PAVBL253S - - 0200	PAVBL4 - - 1 - - 0200
PAVBL453S - - 0270 PAVBL453D - - 0270 PAVBL253S - - 0270	PAVBL4 - - 1 - - 0270



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LT-122 7/03