Apollo® Rack & Pinion Pneumatic Actuators

Installation, Operation, and Maintenance Manual

I941900 Rev. C 09/28/16

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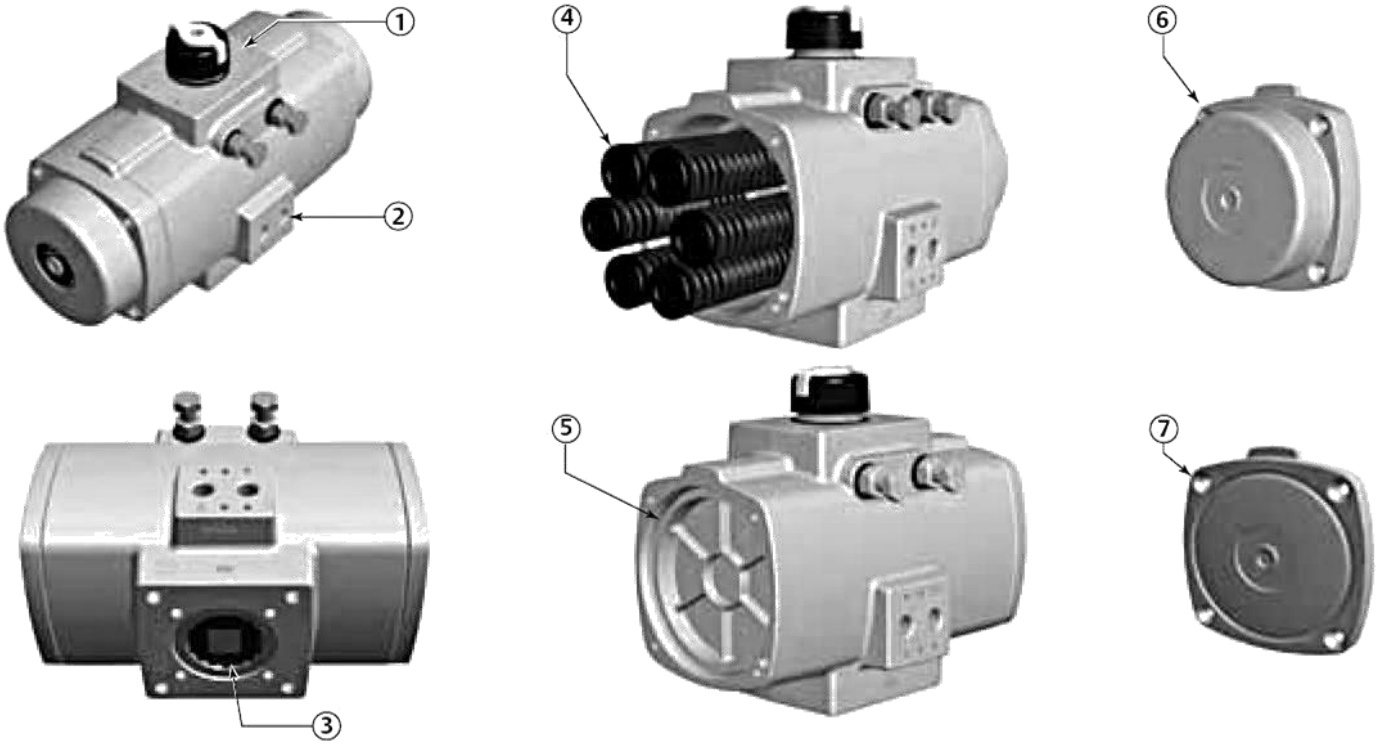
1. Introduction

1.1. Identification

The Apollo Rack and Pinion actuators are available as double-acting or spring-return versions. They are designed to use standardized interfaces for solenoid, switchbox, or positioner mounting (VDI/VDE 3845; NAMUR). The valve interface is equipped with an insert in the pinion bottom that allows for ISO 5211 mounting. The springs in the spring-return version allow a fail action in case of loss of air supply pressure (fail-to-close or fail-to-open). Refer to Figure 1 for product identification.

Figure 1: Product Identification



Item Number	Description
1	Top auxiliaries interface (VDI/VDR 3845; NAMUR)
2	Solenoid Interface (VDI/VDR 3845; NAMUR)
3	Valve interface with ISO 5211 patterns and insert drive
4	Spring-return actuators with springs
5	Double-acting actuators with no springs
6	High end caps for double-acting and spring-return models up to size -0100
7	Low end caps for double-acting models, sizes -0150 and larger

1.2. Warehouse Storage

1.2.1. All actuators should be stored in a clean, dry warehouse, free from excessive vibration and rapid temperature changes.

1.2.2. All actuators should not be stored directly on the floor; they should be placed on racks/shelves or on a pallet.

1.3. On-Site Storage

1.3.1. All actuators should be stored in a clean, dry warehouse, free from excessive vibration and rapid temperature changes.

1.3.2. Care should be taken to prevent moisture and/or dirt from entering the actuator. Plug or seal both air connection ports.

1.4. Intended Use

1.4.1. Actuators are intended for the automation and operation of quarter-turn valves like butterfly, ball, and plug valves. They may also be used to operate other quarter-turn applications such as dampers.

1.5. Specifications

Table 1: Pressure Range

Actuator Type	Spring Quantity	Pressure	
		PSIG	Bar
Double-Acting	n/a	2.9 - 120	0.2 – 8.3
Spring Return	With Max. Spring Set	87 – 120	6 – 8.3
	With Reduced Spring Quantity	43.5 - 120	3 – 8.3

Table 2: Operating Media

Actuator Type	Operating Conditions
Double-Acting & Spring Return	Air, dry or lubricated & inert gas
	Dew point at least 10°C below ambient temperature
	For sub-zero applications, take appropriate measures
	Mentioned pressure levels are “gauge pressures”

Table 3: Temperature Range

Actuator Type	Temperature	
	°F	°C
Standard	-4° – 176°	-20° – 80°
Low Temperature	-40° – 176°	-40° – 80°
High Temperature	-4° – 248°	-20° – 120°

Table 4: Air Volumes and Consumption

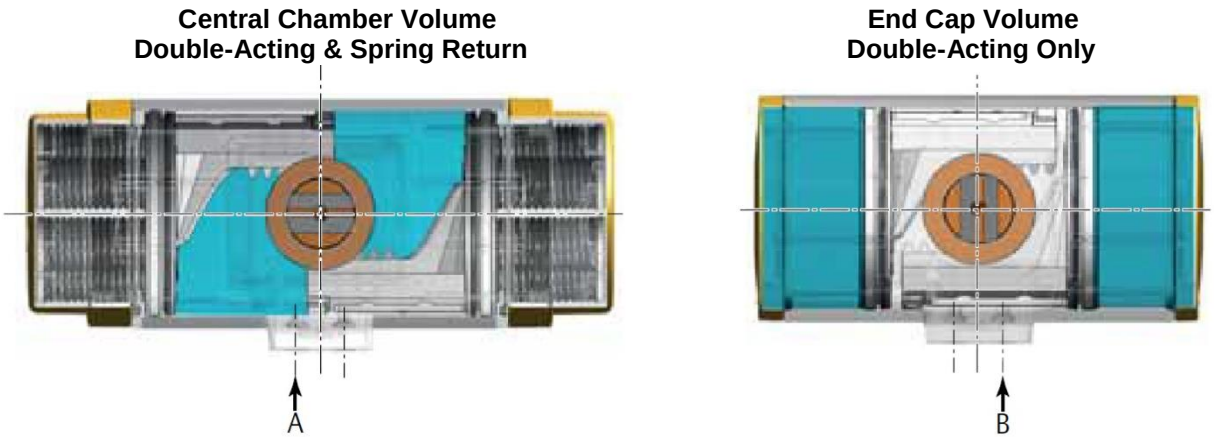
Actuator Volumes				Consumption per Stroke (cu. in.)					
Size	Max. Volume (cu. in.)			Outward Stroke			Inward Stroke		
	Central Chamber[1]	End Cap Chamber[2]	Displaced Volume[3]	Double-Acting & Spring Return			Double-Acting Only		
				2.0	4.0	8.0	2.0	4.0	8.0
0012	3.1	3.7	2.5	11.0	19.0	28.0	13.0	23.0	33.0
0025	6.4	11.8	4.7	28.0	52.0	75.0	38.0	72.0	106.0
0040	10.0	22.0	8.9	53.0	96.0	140.0	71.0	133.0	196.0
0065	22.0	34.0	13.5	81.0	148.0	215.0	107.0	200.0	294.0
0100	22.0	50.0	19.9	118.0	216.0	314.0	165.0	310.0	455.0
0150	48.0	43.0	32.0	192.0	352.0	512.0	163.0	293.0	424.0
0200	50.0	59.0	44.0	255.0	466.0	676.0	220.0	397.0	573.0
0350	118.0	103.0	76.0	436.0	796.0	1157.0	392.0	709.0	1025.0
0600	222.0	201.0	129.0	742.0	1354.0	1967.0	683.0	1237.0	1790.0
0950	310.0	260.0	193.0	1049.0	1905.0	2760.0	910.0	1628.0	2346.0
1600	477.0	430.0	319.0	1635.0	2951.0	4267.0	1505.0	2691.0	3877.0
2500	638.0	676.0	501.0	2259.0	4018.0	5776.0	2367.0	4232.0	6097.0
4000	1122.0	1151.0	853.0	3946.0	7040.0	10134.0	4027.0	7202.0	10377.0

Actuator Volumes				Consumption per Stroke (cu. in.)					
Size	Max. Volume (liters)			Outward Stroke			Inward Stroke		
	Central Chamber[1]	End Cap Chamber[2]	Displaced Volume[3]	Double-Acting & Spring Return			Double-Acting Only		
				2.0	4.0	8.0	2.0	4.0	8.0
0012	0.05	0.06	0.04	0.14	0.24	0.40	0.16	0.28	0.50
0025	0.11	0.19	0.08	0.29	0.50	0.90	0.46	0.85	1.60
0040	0.16	0.36	0.15	0.47	0.80	1.50	0.87	1.60	3.00
0065	0.36	0.55	0.22	0.9	1.60	3.10	1.30	2.40	4.60
0100	0.40	0.80	0.30	1.0	1.70	3.20	2.00	3.60	6.90
0150	0.80	0.70	0.50	2.1	3.60	6.80	1.90	3.40	6.20
0200	0.80	1.00	0.70	2.4	4.00	7.30	2.70	4.60	8.00
0350	1.90	1.70	1.20	5.1	9.00	17.00	5.00	8.00	15.00
0600	3.60	3.30	2.10	8.0	14.00	27.00	8.00	14.00	25.00
0950	5.10	4.30	3.20	13.0	23.00	44.00	12.00	20.00	37.00
1600	7.80	7.00	5.20	21.0	36.00	68.00	19.00	33.00	62.00
2500	10.40	11.10	8.20	29.0	50.00	92.00	30.00	53.00	97.00
4000	18.40	18.90	14.0	51.0	87.00	161.00	52.00	89.00	165.00

Notes:

1. For Double-Acting and Spring-Return. Pistons at 90° outward position.
2. Only for Double-Acting. Pistons at 0° position.
3. Stroke is 90°.

Figure 2: Actuator Volumes



1.6 Assembly Part Numbering System

Example: AS0350N051ACA

A S 0350 N 05 A C A

Action	Size	Temp	Spring Set	Inserts	Fail Position	Rev.
D: Double Acting	0012	**N**: Nitrile Normal Temp. Range -4°F to 175°F	00 (DA)	**A**: Standard Insert	**C**: Fail Closed (FC)	**A**
S: Spring Return	0025		02			
K: Kit	0040		03	**B**: Without Insert	**F**: Fail Open (FO)	
	0065		04			
	0100		05			
	0150	**H**: Fluorocarbon High Temp. Range -4°F to 250°F	06			
	0200		08			
	0350		10		**D**: No Spring (Double Acting Fail Last Position)	
	0600		12			
	0950		14			
	1600	**L**: Silicone Low Temp. Range -40°F to 175°F				
	2500					
	4000					

2. Exploded View & Parts List

Figure 3: Exploded View of Spring Return Actuator

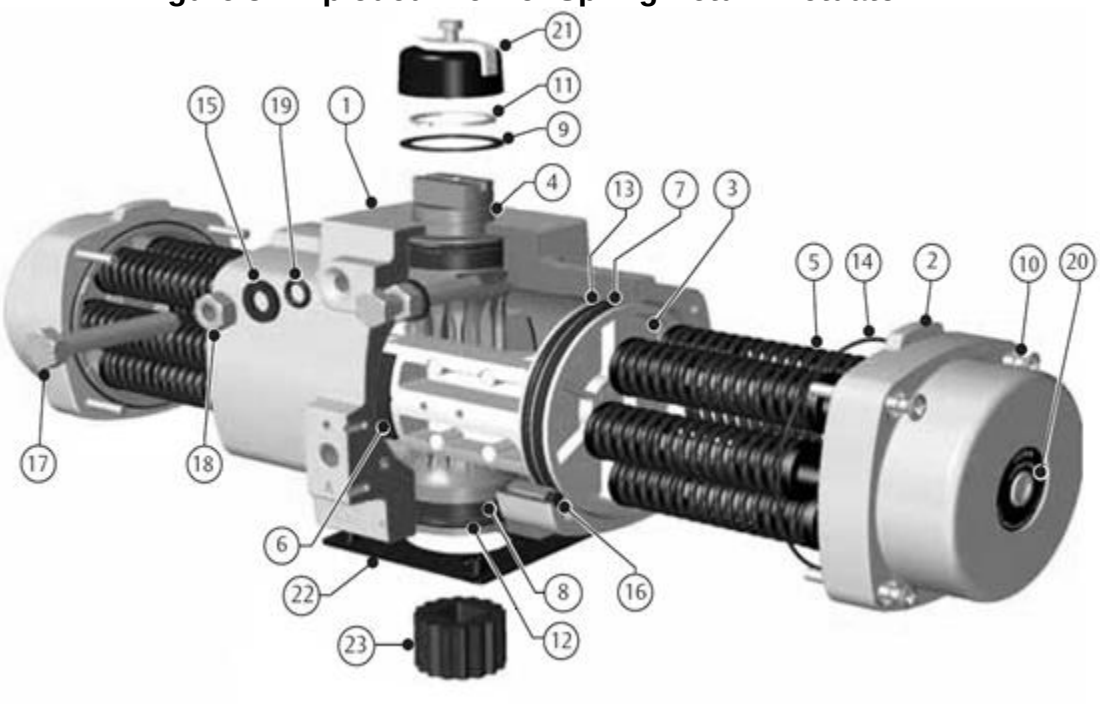


Table 5: Parts List

Pos.	Qty		Description	Material
1	1		House	Cast Aluminium alloy
2	2		End cap	Cast Aluminium alloy
3	2		Piston	Cast Aluminium alloy
4	2		Pinion	High grade aluminium
5	Max. 12		Spring cartridge	Spring steel
6	2	*	Bearing strip piston rack	POM
7	2	*	Bearing piston	PTFE 25% carbon-filled
8	2	*	Bearing pinion	POM
9	1	*	Thrust washer	POM, black UV stabilized
10	8		End cap screw	Stainless Steel
11	1	*	Circlip	Spring steel
12	2	*	O-ring seal pinion	Nitrile rubber
13	2	*	O-ring seal piston	Nitrile rubber
14	2	*	O-ring seal end cap	Nitrile rubber
15	2	*	O-ring seal limit stop	Nitrile rubber
16	2	*	B-port seal	Silicon rubber
17	2		Limit stop screw	Stainless steel
18	2		Limit stop nut	Stainless steel
19	2		Limit stop washer	PA66
20	2		Warning sticker	Polyester
21	1		Indicator assembly	ABS + stainless steel screw
22	1		Center plate (option)	Nylon PA6, Black
23	1		Insert drive	Aluminium

* = included in repair kit

3. Installation

This section explains:

- The “Failure Modes” of an actuator.
- In which position the actuator will end after a failure.
- Principles of operation:
  - Solenoid operation
  - Double acting and Spring return operation
- Assembly codes.
- Actuator to valve assembly

⚠ SAFETY FIRST

In case of an air or electrical failure, it is important to know the behavior of the actuator. Before mounting the actuator on a valve, consult the following sections below.

3.1. Failure Modes

3.1.1. Valve Rotation

For the following paragraphs, we assume that the valves rotate as indicated in Figure 4.

3.1.2. Position after Failure

The position of the actuator after a failure depends on the:

- Principle of operation
- Assembly (code) of the actuator
- Type of failure (see Table 6)

Figure 4: Valve Rotation

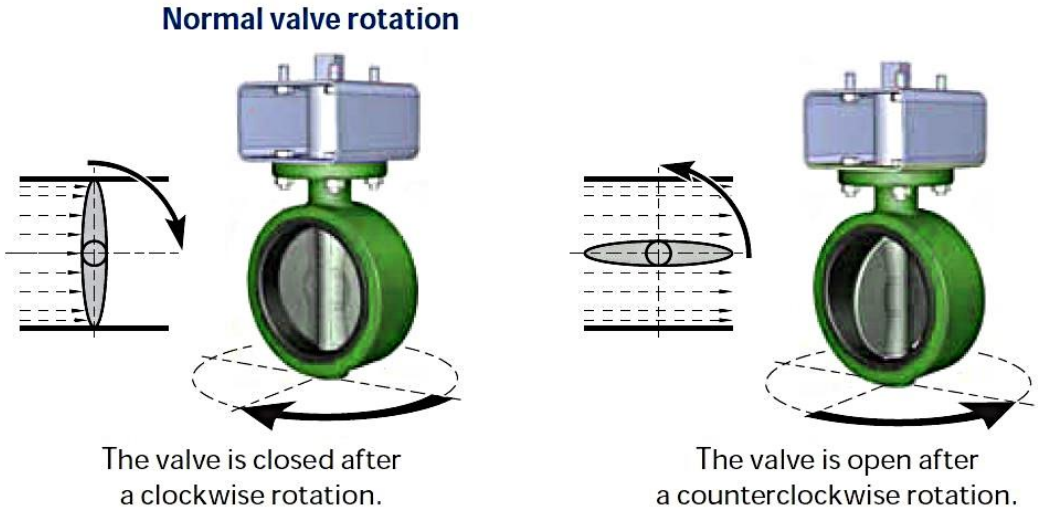


Table 6: Position after Failure

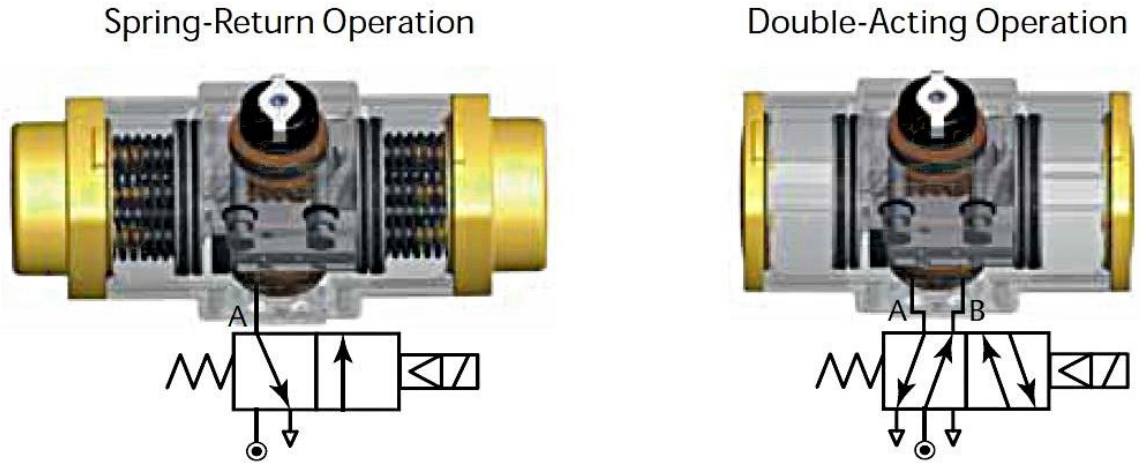
Principle of Operation	Assembly Code	Kind of Failure	Position
Double-Acting Actuator	CW	Pressure	Not defined
		Signal	Closed
		Supply Voltage	Closed
	CC	Pressure	Not defined
		Signal	Open
		Supply Voltage	Open
Single-Acting (Spring-Return) Actuator	CW	Pressure	Closed
		Signal	Closed
		Supply Voltage	Closed
	CC	Pressure	Open
		Signal	Open
		Supply Voltage	Open

3.2 Principles of Operation

3.2.1 Solenoid Valve

All actuators can be either piped with solid or flexible tubing with the solenoid valve mounted remotely from the actuator or by mounting a VDI/VDE 3845 (NAMUR) designed solenoid valve directly onto the NAMUR mounting pad on the side of the actuator.

Figure 5: Solenoid Operation



3.2.2 Operating Speed

Table 7 lists the cycle time for the different actuator sizes. The cycle time is an approximate average with the actuator under load and with a solenoid valve fitted to the NAMUR mounting pad with the following conditions:

- Solenoid flow capacity..... 0.6m^3/hr
- Pipe diameter 6mm
- Medium ..... Clean Air
- Supply pressure .....80psi (5.5 bar)
- Load .....Average load
- Stroke..... 90°
- Temperature..... Ambient

Table 7: Operating Speed

Cycle time in seconds				
Actuator Size	Spring-Return		Double-Acting	
	A-port pressurized	Spring stroke	A-port pressurized	B-port pressurized
0012	0.4	0.4	0.4	0.4
0025	0.5	0.4	0.5	0.4
0040	0.6	0.5	0.6	0.5
0065	0.7	0.5	0.6	0.6
0100	0.8	0.6	0.8	0.7
0150	1.0	0.8	0.9	0.8
0200	1.3	0.9	1.0	1.0
0350	1.9	1.3	1.4	1.5
0600	3.2	1.9	2.2	2.2
0950	4.6	3.2	3.9	3.6
1600	6.9	4.8	5.9	4.8
2500	9.0	6.3	7.8	7.9
4000	15.4	10.8	13.3	13.0

3.2.3 Ingress Protection (IP) Rating

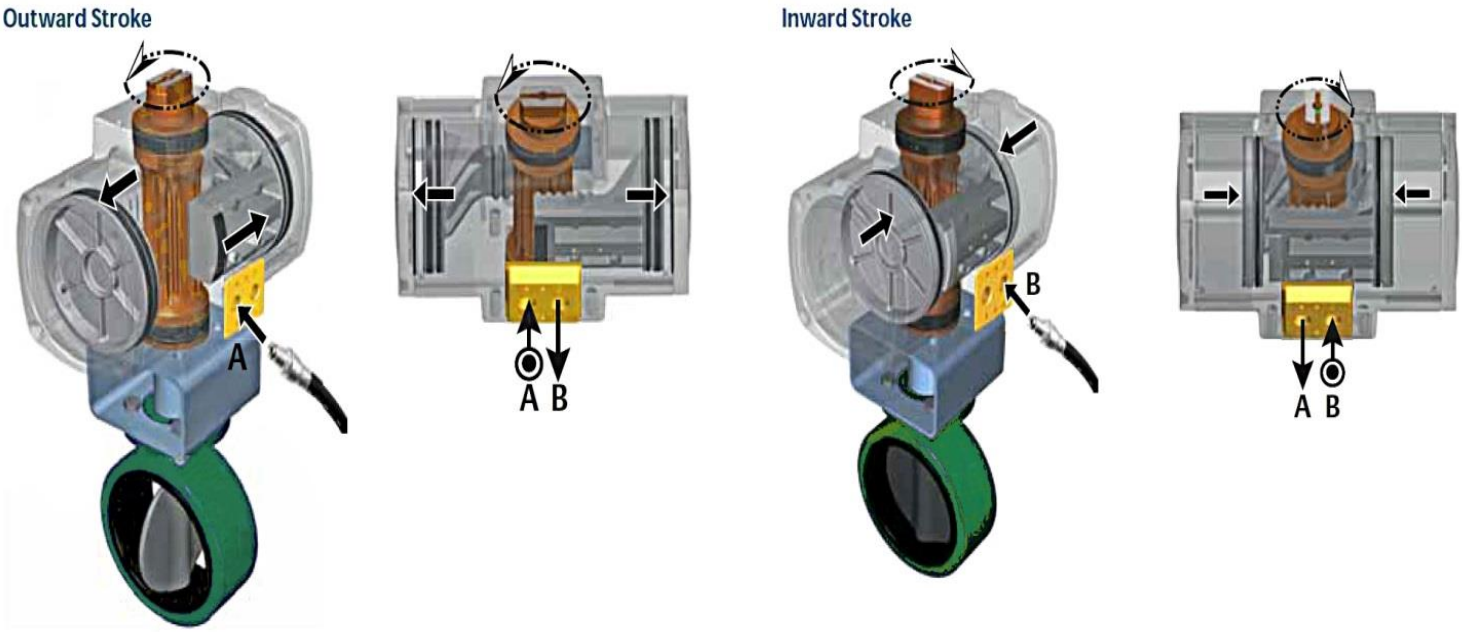
Apollo Actuators are IP66/IP67 rated. When IP66 or IP67 requirements are demanded, take precautions to prevent moisture or dust from entering the actuator through the open air exhaust port(s), either directly on the actuator or at the exhaust ports of the connected solenoid valve. It is recommended to connect tubing to the exhaust(s) and lead into a dry and dust free area, or use a suitable check valve(s) in the exhaust(s).

3.2.4 Double-Acting Actuators

The operating principles for actuators with assembly code “CW” direct acting are listed below. The assembly code is printed on a decal located on the actuator body (NAMUR mounting pad side).

- Applying supply pressure to port A will move the pistons outward to the “Open” position of the valve
- Applying supply pressure to port B will move the pistons inward to the “Close” position of the valve
- For assembly codes “CC”, the operating principle is reversed (reverse acting)

Figure 6: Double-Acting Operation

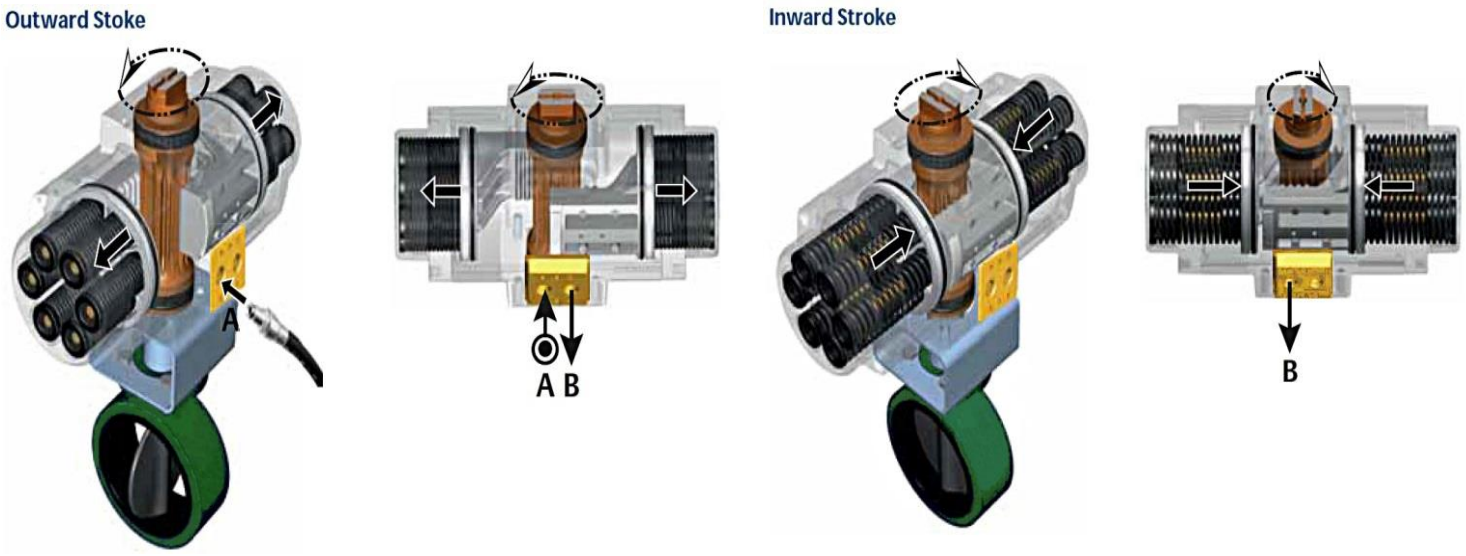


3.2.5 Spring Return Actuators

The operating principles for actuators with assembly code “CW” are listed below. The assembly code is printed on a decal located on the actuator body (NAMUR mounting pad side).

- Applying supply pressure to port A will move the pistons outwards to the “Open” position of the valve.
- Venting the supply pressure from port A will cause the springs to move the pistons inwards to the “Close” position of the valve.
- For assembly codes “CC”, the operating principle is reversed (reverse acting).

Figure 7: Spring Return Operation



3.3 Actuator Assembly Codes

Figure 8: Assembly Code – Double-Acting Actuator

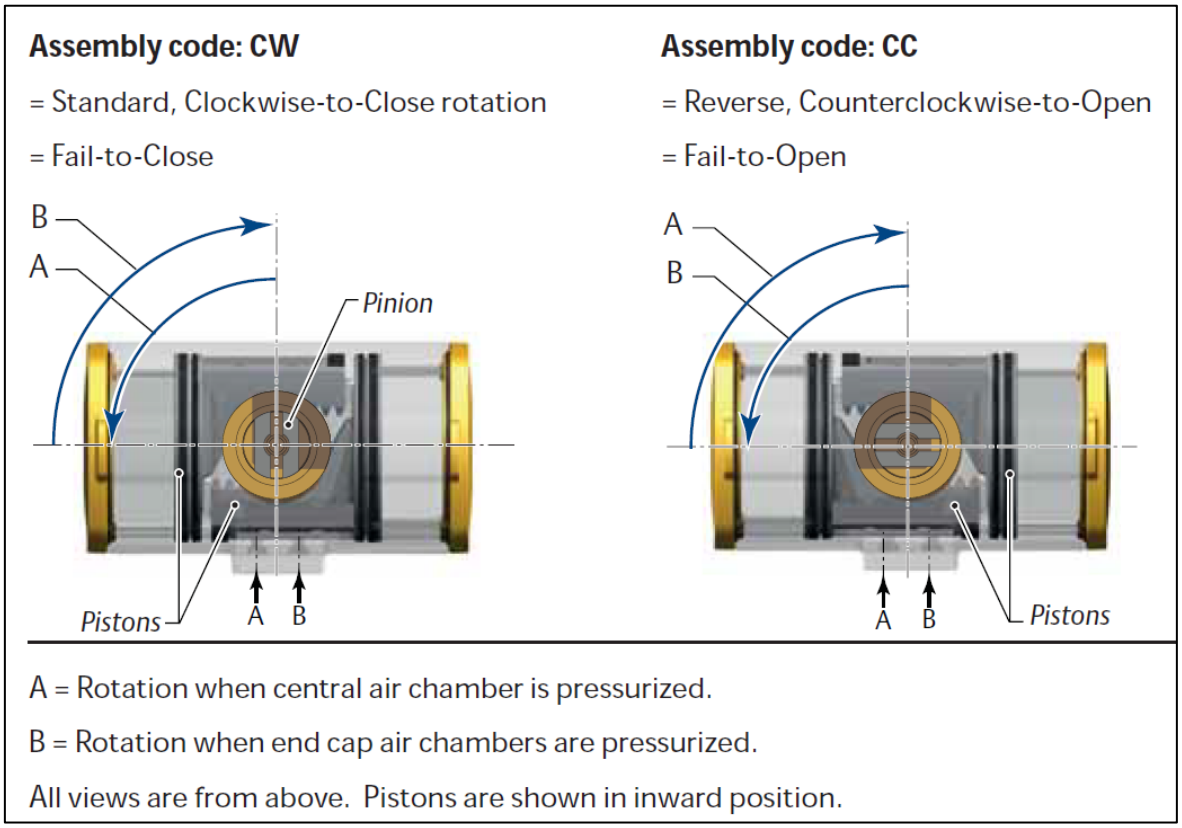
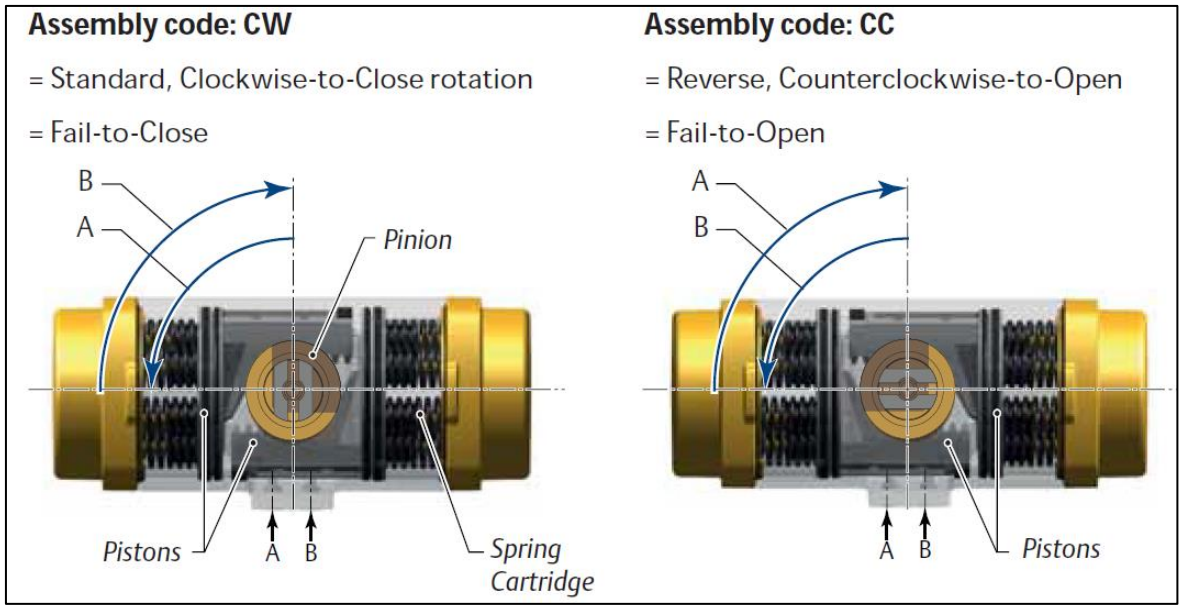


Figure 9: Assembly code- Spring Return Actuator



3.4 Actuator to Valve Installation

⚠ WARNING - MOVING PARTS

- Actuators must be isolated pneumatically and electrically before any (dis)assembly starts.
- Stay away from moving parts to prevent serious injury. When test cycling the actuator and valve assembly by applying pressure to the A or B port, be aware that there are moving parts.
- Do not attempt to work on valves or actuators that are pressurized.
- Ball valves and plug valves can trap pressure in the body cavity. Isolate the piping system in which the valve/actuator assembly is installed and relieve any pressure on or in the valve.

NOTICE

- The actuator is designed to be installed and maintained using generic tools like wrenches, Allen keys, and screwdrivers. For the removal of inserts, a special extractor must be used.

- During assembly to the valve, do not hit the top of the pinion with a hammer. This can damage the pinion top washer and cause premature failure.
- Before mounting the actuator on the valve or valve bracket, be sure that both the actuator and the valve are in the same closed or open position.
- Refer to Table 9 for end cap bolt tool and torque values.
- Refer to Table 10 for bottom flange torque values.

Table 8: Tools Required

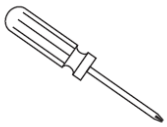
Symbol	Tool	Symbol	Tool
	Wrench – All types and sizes. Metric and Imperial		Phillips -H- screw driver for actuator sizes 0025 to 0600.
	Circlip Pliers		Allen key for actuator size 0012

Table 9: Tool and Torque Values for End Cap Bolts

Actuator Size	Thread	Tool	Size	Torque (Nm)			Torque (lbf-ft)		
				Target	Min.	Max.	Target	Min.	Max.
0012	M4	Allen Key	SW 3	1.1	0.8	1.3	0.8	0.6	1
0025	M5	Philips -H- Screwdriver	No. 2	2	1.6	3	1.5	1.2	2.2
0040	M5		No. 2	2	1.6	3	1.5	1.2	2.2
0065	M5		No. 2	2	1.6	3	1.5	1.2	2.2
0100	M5		No. 2	2	1.6	3	1.5	1.2	2.2
0150	M6		No. 3	3.3	2.6	5.1	2.4	1.9	3.8
0200	M6		No. 3	3.3	2.6	5.1	2.4	1.9	3.8
0350	M8		No. 4	8.4	6.7	12.2	6.2	4.9	9
0600	M10		No. 4	15.3	12.2	24.8	11.3	9	18.3
0950									
1600									
2500									
4000									

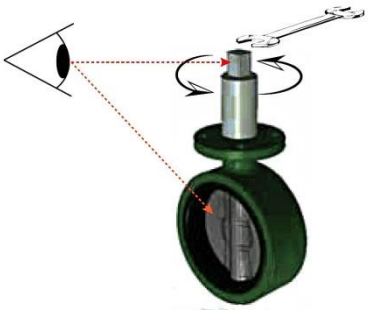
Table 10: Torque Values for Bottom Flange

Actuator Size	Iso Pattern	Metric Thread	Torque (Nm)		Imperial Thread	Torque (lbf-ft)	
			Min.	Max.		Min.	Max.
0012	F4	M6	4.5	5.0	10-24UNC	3.3	3.7
0025	F3	M5	2.0	3.0	10-24UNC	1.5	2.2
	F5	M6	4.5	5.0	1/4"-20	3.3	3.7
0040, 65, 100	F5	M6	4.5	5.0	1/4"-20	3.3	3.7
	F7	M8	10.5	12.5	5/16"-18	7.7	9.2
0150, 200, 350	F7	M8	10.5	12.5	5/16"-18	7.7	9.2
	F10	M10	21.0	24.5	3/8"-16	15.5	18.1
0600	F10	M10	21.0	24.5	3/8"-16	15.5	18.1
	F12	M12	34.5	43.0	1/2"-13	25.4	31.7
0950	F10	M10			3/8"-16		
	F14	M16			5/8"-11		
1600	F16	M20			3/4"-10		
	F25	M16			5/8"-11		
2500	F16	M20			3/4"-10		
	F25	M16			5/8"-11		
4000	F16	M20			3/4"-10		
	F25	M16			5/8"-11		

3.4.1 Double-Acting Installation

3.4.1.1 Note the position of the valve. If at all possible, place the valve in the fully open position (Fig. 10).

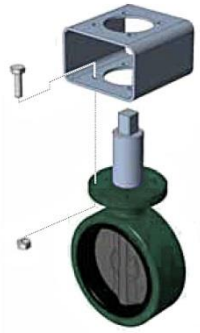
Figure 10: Valve Position



3.4.1.2 Remove the handle and stops to clear the top-works of the valve. Do not remove features that control packing adjustments with the valve under pressure.

3.4.1.3 If a standoff bracket is required, mount it to the valve first with the provided hardware, oriented to provide the most convenient access to the valve packing adjustment, if applicable. Install fasteners hand-tight at this time (Fig. 11).

Figure 11: Bracket Connection

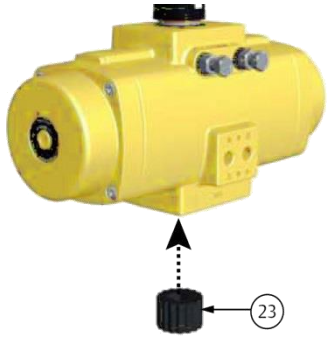


3.4.1.4 Ball valves, butterfly valves, and plug valves are designed to operate in 90° of rotation. Convention requires that the operator be installed to provide “clockwise (CW) to close” operation.

3.4.1.5 Normal installation of the actuator is inline with the piping system. Installation perpendicular to the pipeline can be used to address space limitations but, the clockwise to close rotation should be maintained if at all possible.

3.4.1.6 Pressure applied to the port labeled “A” will verify that the actuator is in the full CW position or to port “B” to confirm full CW position.

Figure 12: Actuator Coupling



3.4.1.7 If a coupling was supplied with the mounting kit, verify its smooth fitment in the adapter/insert provided with the actuator.

3.4.1.8 If the insert was supplied loose, install it in the actuator. Install the coupling on the valve stem.

3.4.1.9 Slide the actuator over the coupling in the proper orientation.

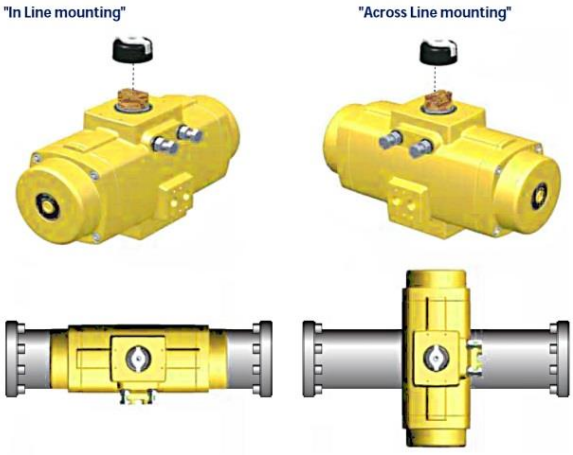
3.4.1.10 The upper bracket fasteners should start with little to no effort. Tighten finger tight. If they do not align properly, do not disturb the valve's position, instead refer to section 3.5.1 "Travel Stop Adjustment" and adjust the actuators position after backing off the travel limit stops.

3.4.1.11 Tighten all fasteners and temporarily connect a pressure source to "B" port and strike the valve open observing the coupling and/or actuator for smooth operation. Jerky motion suggests binding in the assembly. Loosen all mounting hardware fasteners, allow the package to self-align and re-tighten. Stroke the assembly again and repeat if necessary to achieve smooth operation.

3.4.1.12 Verify full 90° of actuator rotation. If adjustments were made in step 3.4.1.10, closed position adjustment may be necessary.

3.4.2 Spring Return Installation

Figure 12: Actuator Coupling



3.4.2.1 Spring return actuator installation follows the same process as installing a double acting actuator with some extra considerations. Actuators intended for fail open service require special factory preparation. Verify that the model number contains an "F" in the next to last digit. If not, contact the factory for the proper actuator.

Refer to Figure 12 for the following:

3.4.2.2 <u>Fail Closed In-line (CW)</u>: This procedure is exactly as described for the double acting actuator, see Section 3.4.1.

3.4.2.3 <u>Fail Closed Perpendicular (CW)</u>: If the actuator output is a square drive, with the actuator in the full CW position, slide it on the stem or coupling crossways of the pipeline. If the actuator output is a "double-d" style, it will be necessary to remove the adapter insert, turn it 90° and reinstall it before sliding it onto the valve stem or coupling. Install

the balance of the hardware as described in Sections 3.4.1.10 through 3.4.1.12.

3.4.2.4 Fail-Open In-line (CW): After verifying that the next to last digit of the part number contains an "F", the procedure is the same as described for the double acting actuator, see section 3.4.1.

3.4.2.5 Fail Open Perpendicular (CW): After verifying that the next to last digit of the part number contains an "F" and the actuator output is a square drive, with the actuator in the full CW position, slide it on the stem or coupling crossways of the pipeline. If the actuator output is a "double-d" style, it will be necessary to remove the adapter insert, rotate it 90° and reinstall it before sliding in onto the valve stem or coupling. Install the balance of the hardware as described in Sections 3.4.1.10 through 3.4.1.12.

3.5 Mechanical Stroke Adjustment

This section explains:

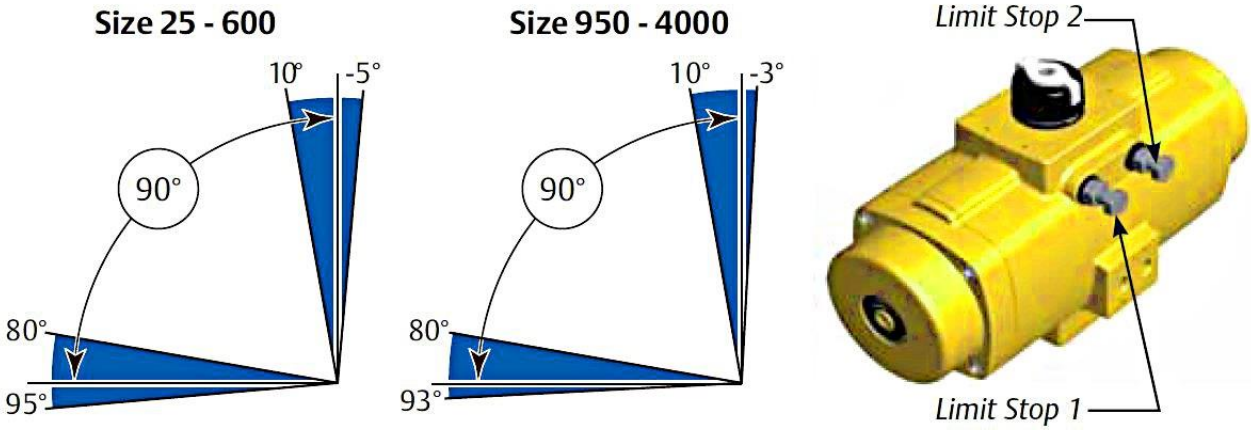
- What mechanical stroke adjustment is.
- What the factory settings are.
- How to adjust the travel stops.

Actuator sizes 0025 to 4000 have two stroke adjustment stops for adjusting accurately the stroke of the actuator/valve assembly in the open and closed position.

The smallest actuator, 0012, does not have limit stops.

The factory setting of the stroke is 90°. Most quarter-turn valve applications will not require readjustment of these settings. If required, the stroke can be adjusted by means of two-stroke adjustment bolts.

Figure 13: Factory Stroke Adjustment Settings



⚠ CAUTION - PRESSURIZED ACTUATOR

3.5.1 Travel Stop Adjustments

Do not turn out the travel stops completely when the actuator is pressurized. When adjusting the travel stops and the actuator is still pressurized, the travel stops can become projectiles when completely turned out.

3.5.1.1 Double-Acting Actuators

1. Operate the valve/actuator assembly to the “Closed” position.
2. Remove air supply.
3. Loosen the locknut on the “closed” stop (Fig. 13, Limit Stop 2).
4. Turn the “closed” stop clockwise to reduce or counterclockwise to increase the travel.
5. Tighten the lock nut.
6. Connect the air supply and cycle the actuator to check that the position is correct. If not repeat from Step “2”.
7. Remove air supply.
8. For adjusting the open position repeat Steps “1” to “7”, but using the “open” stop (Fig. 13, Limit Stop 1).

3.5.1.2 Spring Return Actuators

1. Connect the air supply to the “A” port. The actuator will move to the open position.
2. Loosen the locknut on the “closed” stop (Fig. 13, Limit Stop 2.
3. Turn the “closed” stop clockwise to reduce or counterclockwise to increase the travel.
4. Tighten the lock nut.
5. Remove air supply. Actuator will move to the closed position.
6. Determine if the actuator valve assembly is in the required position. If not repeat Steps “1” to “6”.
7. Remove air supply.
8. For adjusting the “open” position, repeat Steps “1” to “7”, but now for the “open” stop (Fig 13, Limit Stop 1).

NOTICE

In case of air leakage over the limit stop bolts, turn the lock nut of the limit stop bolts tighter, until leakage stops.

3.6 Recommended Tubing Sizes

In case the solenoid valve is mounted remotely, and in order to supply a sufficient flow of air supply to the actuator, the following tubing sizes are recommend (Table 11).

Table 11: Tubing Sizes

Actuator Size	Distances up to		Distances Greater than	
	4 Feet	1.2 Meters	4 Feet	1.2 Meters
0025, 0040, 0065	¼”	6mm	¼”	6mm
0100, 0150, 0200, 0350, 0600	¼”	6mm	5/16”	8mm
0950, 1600, 2500, 4000	¼”	6mm	3/8”	10mm

3.7 Mounting of Control and Feedback Accessories

Solenoid valves and/or switch boxes can be mounted to the actuator. Check the instructions as shipped with these components for installation, operating, and maintenance instructions.

It is recommended to test-cycle the complete assembly to check for correct operation.

4. Maintenance

This section explains:

- When and how to do maintenance.
- What to do when replacing stops.
- What is the availability of spare parts, action conversion kits, and temperature conversion kits.

4.1. General

- Apollo actuators are designed to operate without maintenance for their normal working life. Normal working life is 500,000 cycles (one open stroke and one close stroke).
- It is recommended that regular inspections be conducted to make certain the actuator/valve assembly operates smoothly and to check that there are no visible or audible defects.
- Replacement of internal seals and bearings allow for extended working life. Repair kits containing all necessary seals, bearings, grease, and instructions can be obtained through Apollo Valve distributors.
- All actuators are supplied with sufficient lubrication for their normal working life. If required, see Section 7.1, Grease Instructions.
- For mounting the parts of the repair kit, follow the instructions laid out in the Decommission, Disassembly, and Reassembly chapters of this manual.

4.2. Repair

4.2.1. Spring Return Actuator

- On spring-return actuators, the spring cartridges can be replaced. Spring cartridges should always be replaced in complete sets.

4.2.2. Recommended Spare Parts

- All soft seals, bearings, and non-reusable parts are included in the recommended spare parts kits. The spare parts kit is identical for both the double-acting and the spring-return models. For the spring-return models, it is recommended that spare springs for each different model be stocked in addition to the recommended spare parts kits.

5. Decommission (Out of Service)

This section explains how to decommission an actuator in a safe manner.

5.1. Before Starting

⚠ WARNING - MOVING PARTS

5.1.1. The actuator must be isolated pneumatically and electrically before any (dis)assembly starts. Before mounting or (dis)assembling the actuator, consult the relevant sections of this manual. Actuators can move when removing supply pressure and/or electrical control signals from the actuator. If not already there, a spring-return actuator will cycle to the fail position. When removing any ball valve or plug valve assemblies from a pipe system, isolate the piping system on which the actuator is installed and relieve any media pressure that may be trapped in the valve cavities before removing the actuator for maintenance. A spring-return actuator mounted on a valve, which is stuck in mid-stroke, contains a high spring load which will cause a sudden rotation of the actuator versus the valve or valve bracket during disassembly. This can cause serious injury to personnel or damage to property.

Refer to Appendix A for instructions to safely remove the spring load before disassembling the spring-return actuator from a valve or bracket.

5.2. Removing the Actuator from the Valve (Refer to Figure 14)

5.2.1. Remove all air supply hoses (Port A and/or Port B and/or Solenoid).
5.2.2. Disconnect all electrical wirings from the switch box (if applicable).
5.2.3. Disconnect the electrical wiring from the solenoid valve (if applicable).
5.2.4. Remove the fasteners from the valve flange.
5.2.5. Remove the bracket from the actuator.
5.2.6. Remove the switch box and solenoid valve. Refer to the documentation supplied with the switch box and solenoid for safe disassembly.

Figure 14: Removing Actuator from Valve/Bracket

6. Disassembly

This section explains how to disassemble an actuator safely.

⚠ WARNING

- The actuator must be isolated pneumatically and electrically before any (dis)assembly starts. Before mounting or (dis)assembling the actuator consult the relevant sections of this manual.

⚠ CAUTION - SPRING FORCE

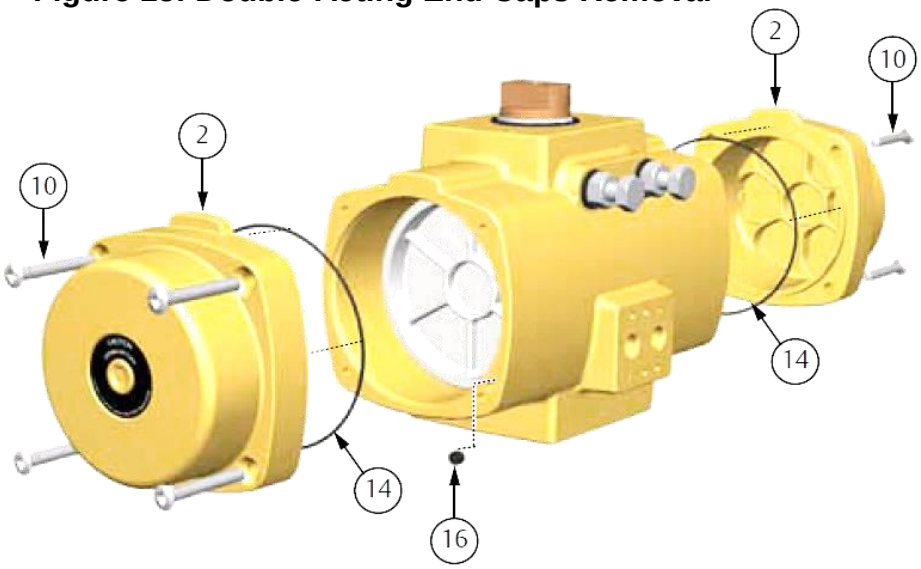
- Spring-return actuators contain springs in a compressed state. Follow these instructions to release the spring force safely.
- Normally the end caps of spring-return actuators should be free of the spring load after 10 full turns of the end cap screws. If there is still load on the end cap, this might indicate a broken spring cartridge. Stop the disassembly procedure immediately. Continuing may cause the end cap to be ejected, causing series injury.
- Refer to Appendix A for instructions to safely remove the spring load before disassembling the end cap of a spring-return actuator with a broken spring cartridge.

6.1. Removing End Caps

6.1.1. For Double-Acting Actuators:

a. Loosen the screws (10) on the end caps (2).
b. Remove the O-ring (14) and “B” port seal (16). Discard these parts.

Figure 15: Double-Acting End Caps Removal

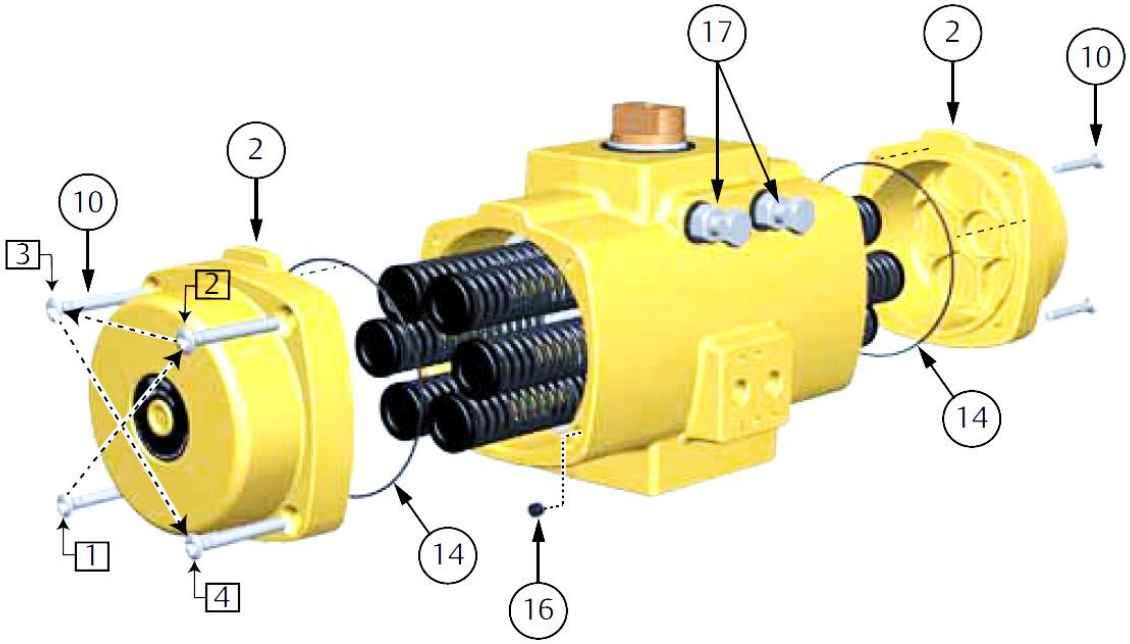


- The above end caps (2) are for actuator sizes 0025, 0040, 0065, and 0100.
- End caps for actuator sizes 0150 and larger will have flat end caps (see far left).

6.1.2 For Spring-Return Actuators:

a. For actuators with assembly code CW, turn back the right hand limit stop screw (17) two full turns. For actuators with assembly code CC, turn back the left hand limit stop (17) two full turns. This will lower the spring force on the end cap and reduce the screw out length of the end cap screws.
b. Loosen all of the end cap screws (10) for maximum ¼ turn.
c. Uniformly loosen the screws (10) of the end caps (2) ¼ - ½ turns at a time, in sequence, as per Figure 16, to relieve the pre-load of the springs.
d. Remove the O-rings (14) and “B” port seals (16). Discard these parts.

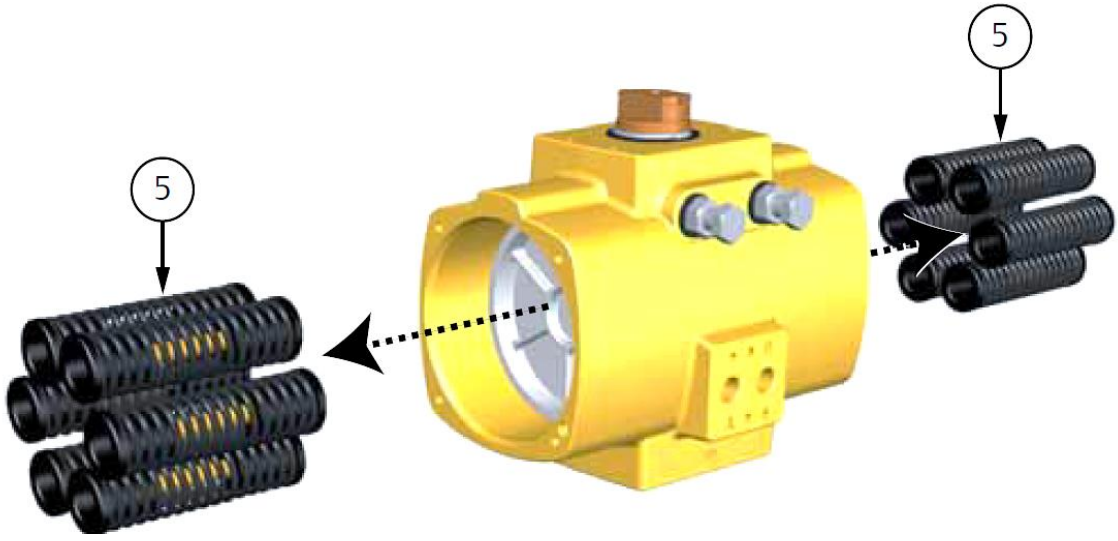
Figure 16: Spring-Return End Caps Remova



6.2. Removing Spring Cartridges (Spring-Return)

6.2.1. Remove the spring cartridges (5). See Figure 17.

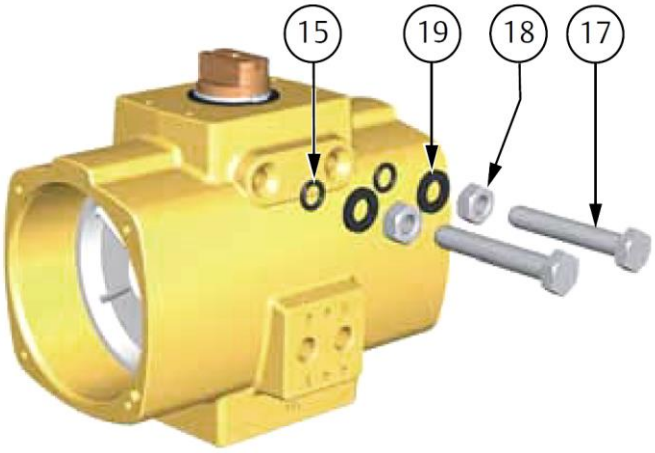
Figure 17: Spring Cartridge Removal



6.3. Removing of Limit Stop

6.3.1. Remove the limit stop screws (17), limit stop nuts (18), limit stop washers (19), and limit stop O-rings (15). Discard the O-rings. See Figure 18.

Figure 18: Limit Stop Removal

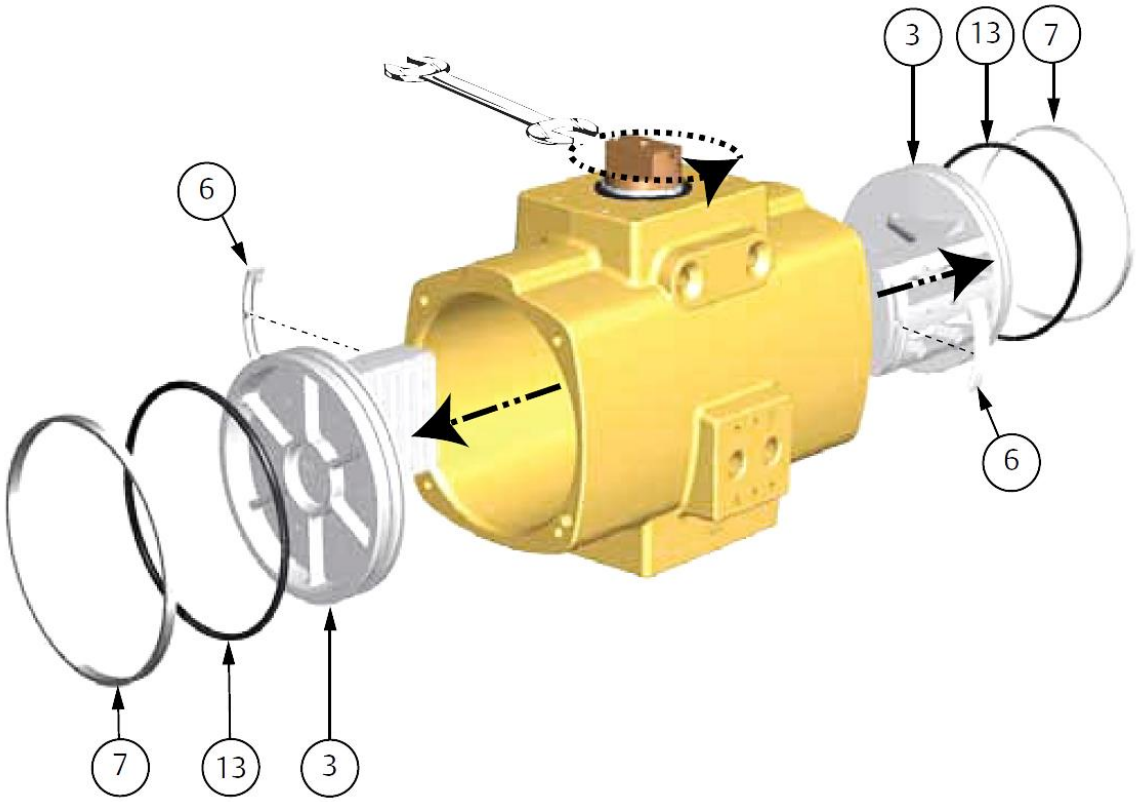


6.4. Removing Pistons

6.4.1. Use a wrench and turn the pinion counter-clockwise (180°) until the pistons (3) come out of the body. Refer to Figure 19.

6.4.2. Remove the piston bearings (7), piston rack bearing strips (6), and piston O-ring seals (13). Discard these parts.

Figure 19: Piston Removal



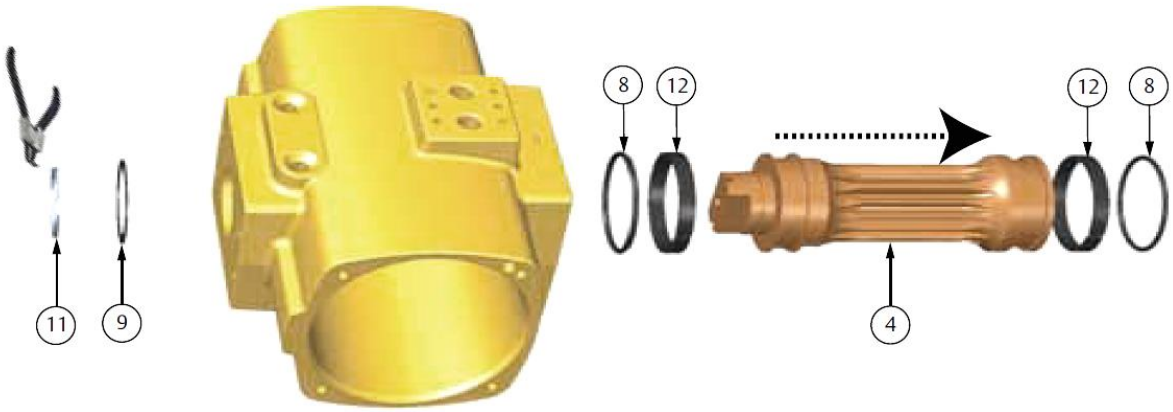
6.5. Removing Pinion

6.5.1. Remove the circlip (11) and thrust washer (9) on top of the pinion assembly. Discard if necessary, the circlip (11) and thrust washer (9). Refer to Figure 20.

6.5.2. Remove the pinion (4) by pushing it out of the actuator housing (as shown in Figure 20).

6.5.3. Remove the pinion O-ring seals (12) and the pinion bearings (8). Discard all of these parts.

Figure 20: Pinion Removal



6.6. Cleaning the Body

In case of maintenance, use a clean dry cloth and thoroughly wipe clean and remove old grease from:

- The inside and outside of the body including threaded holes and crevices/grooves
- The pinion gears
- The pistons

7. Reassembly

This section explains:

- Which parts and how to grease them.
- How to reassemble a complete actuator.
- How to set the stroke adjustment bolts after reassembly.
- How to do a basic function and air leak test.

7.1. Grease Instructions

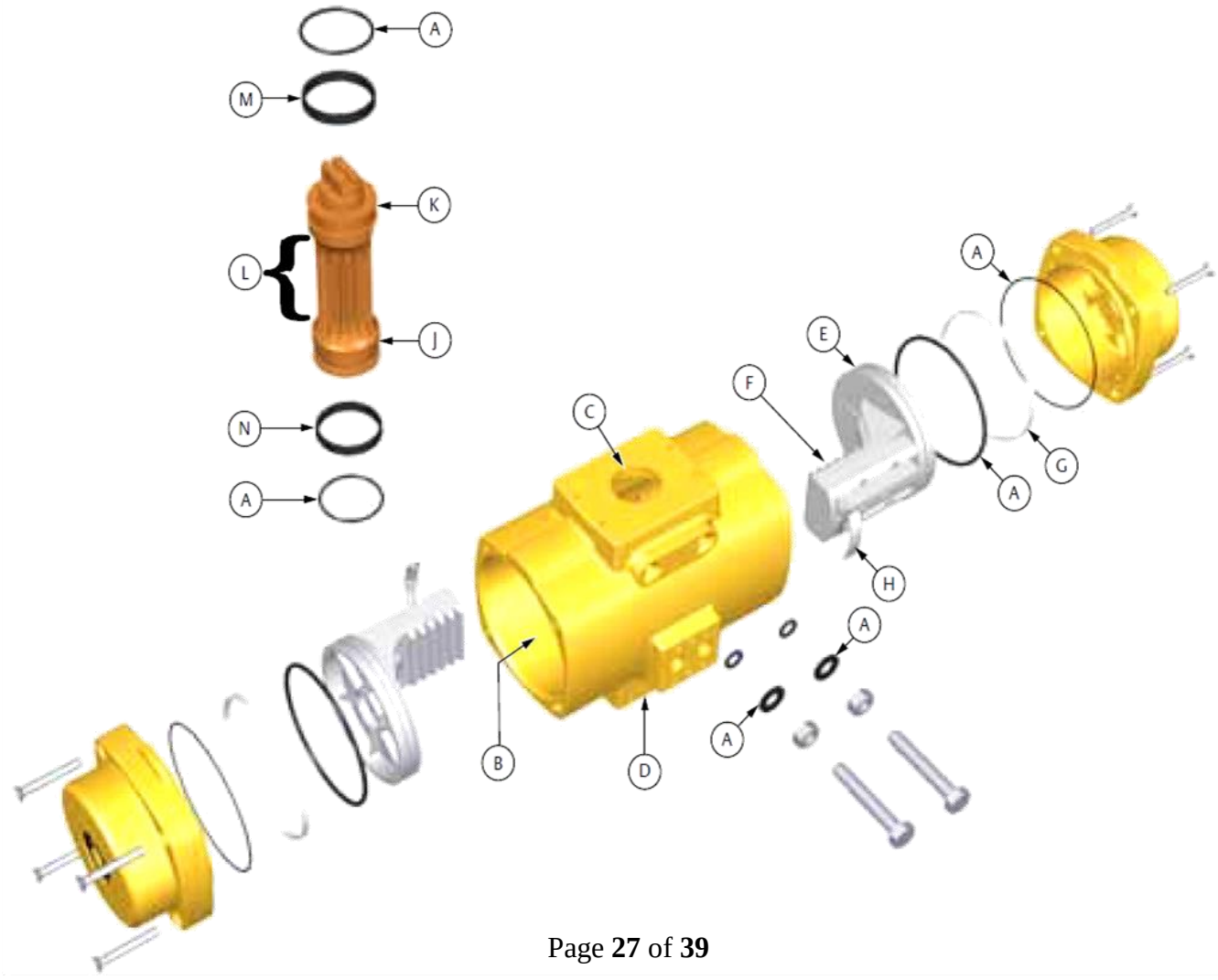
- Check the product coding on the product labels to define which type of grease to use.
  - For standard actuators (-4°F to +176°F / -20°C to +80°C), use Castrol High Temperature grease (or equivalent).
  - For low temperature operation (-40°F to +176°F / -40°C to +80°C), use Castrol Optitemp TT1 grease (or equivalent).
  - For high temperate operation (-4°F to +248°F / -20°C to +120°C), use Castrol High Temperature grease (or equivalent).

- It is recommended to use a suitable sized brush to apply the required amount of grease on the parts as per Table 12 and Figure 21.

Table 12: Grease Instructions

Part		Section of Part	Amount of Grease
O-Rings	A	Completely	Light film
Housing Parts	B	Piston bore	Light film
	C	Top of pinion bore	Light film
	D	Bottom of pinion bore	Light film
Piston Parts	E	O-ring and bearing groove	Light film
	F	Rack teeth	Half the teeth depth full of grease
	G	Piston bearing	Light film on outside
	H	Piston rack bearing strip	Light film
Piston Parts	J	Pinion bottom and O-ring groove	Light film
	K	Pinion top and O-ring groove	Light film
	L	Gear teeth	Half the teeth depth
	M	Pinion top bearing	Light film (inside and out)
	N	Pinion bottom bearing	Light film (inside and out)

Figure 21: Grease Instructions



7.2. Reassembly of the Pinion

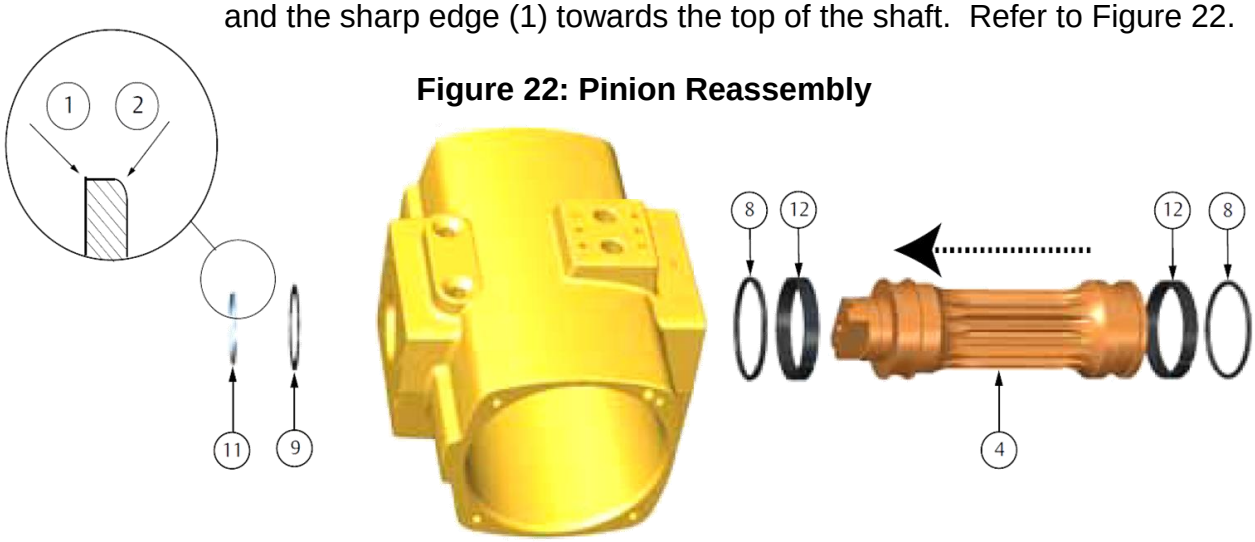
7.2.1. Grease the pinion parts according to Section 7.1.

7.2.2. Install the pinion bearings (8) and O-ring seals (12) on the pinion (4). Refer to Figure 22.

7.2.3. Insert the pinion (4) into the actuator housing.

7.2.4. Install the thrust washer (9) and mount the circlip (11) on the pinion top using circlip pliers. Install the new circlip onto its mating groove on the top shaft extension and with the non-sharp edge (2) towards the housing and the sharp edge (1) towards the top of the shaft. Refer to Figure 22.

Figure 22: Pinion Reassembly



7.3. Reassembly of the Pistons

7.3.1. Before reassembling the pistons, check the required assembly code.

7.3.2. Grease the piston parts according to Section 7.1.

7.3.3. Install the piston bearings (7), piston rack bearing strips (6), and piston O-ring seals (13) on the pistons. Ensure all parts remain in place during assembly. Refer to Figure 23.

7.3.4. Align the pinion (refer to Figure 24) so that the teeth on the pinion will mesh with the piston's rack teeth when turning the pinion. Note the position of the pinion top slot and cam on the pinion top:

- For standard or Spring-to-Close: Assembly Code CW
- For reverse or Spring-to-Open: Assembly Code CC

7.3.5 Slightly push the pistons inward to engage the pinion.

- Ensure that smooth movement and 90° operation can occur without moving the pistons out of the actuator body.
- For larger pistons, use a rubber mallet and slightly hitting the pistons inward to engage the pinion.

7.3.6 When the pistons are moved 90° inwards (refer to Figure 24), check that the pinion slot on the pinion top is:

- Perpendicular to the length center line of the housing for assembly code CW.
- In-line to the length center line of the housing for assembly code CC.

7.3.7 If not, turn the pinion to move the pistons outward until they disengage from the pinion. Shift one tooth of the pinion, reassemble, and check again.

7.3.8 When the pistons are completely moved inwards, the pinion top will show a 5° over travel.

Figure 23: Piston Reassembly

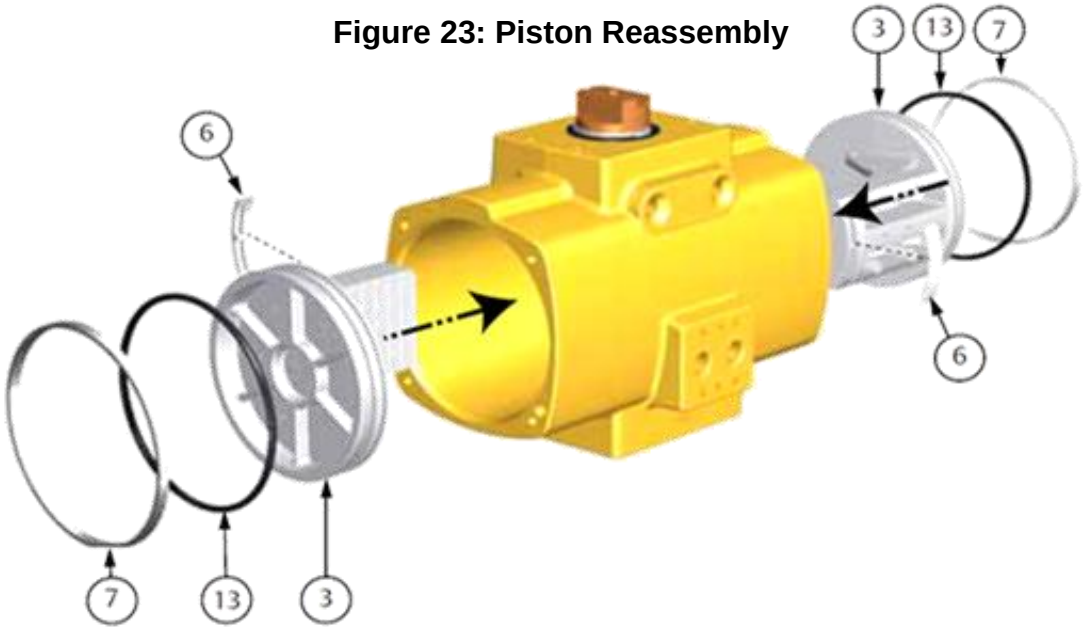
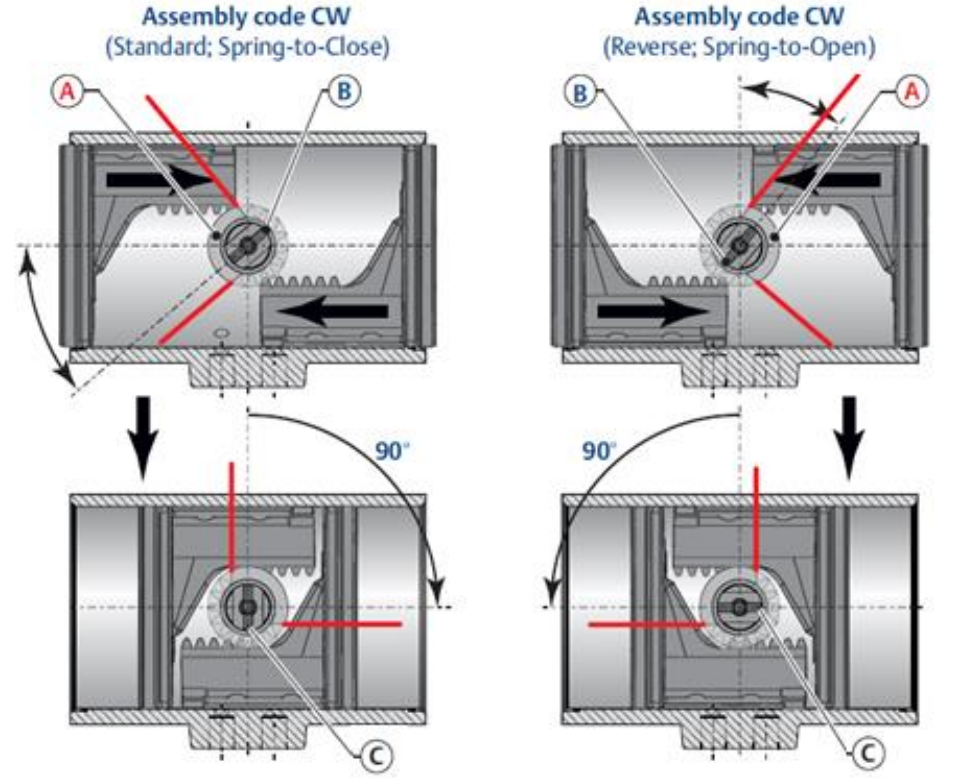


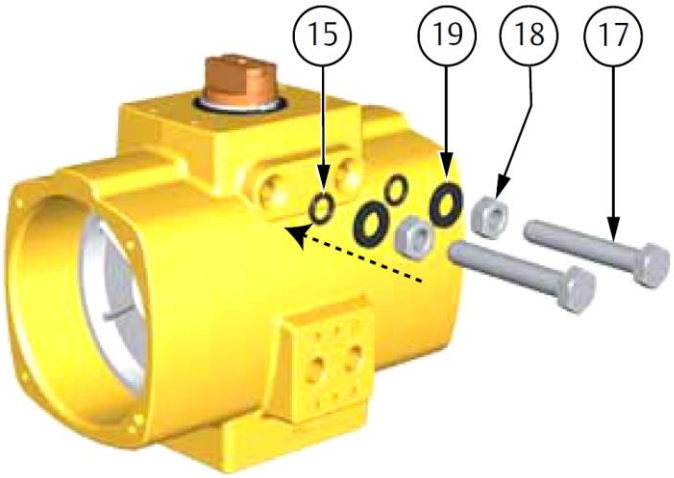
Figure 24: Position of Pistons on Pinion



7.4. Reassembly and Settings of the Limit Stops

7.4.1. Install the limit stop screws (17), limit stop nuts (18), limit stop washers (19), and limit stop O-rings (15). Refer to Figure 25.

Figure 25: Install of Limit Stop Screws



7.4.2. Move the pistons inward until the slot in the top of the pinion is perpendicular to the centerline of the housing.

7.4.3. Double check to see if the position of the slot and the cam on the pinion top is in the correct position (refer to Figure 24). Screw in the right hand travel stop until it comes into contact with the pinion stop face.

7.4.4. Move the pistons outward until the slot in the top of the pinion is in-line with the centerline of the housing.

7.4.5. Screw in the left hand travel stop until it comes into contact with pinion stop face.

7.4.6. For accurate travel stop adjustment of the actuator on the valve, see Section 3.5.

7.5. Reassembly of the End Caps

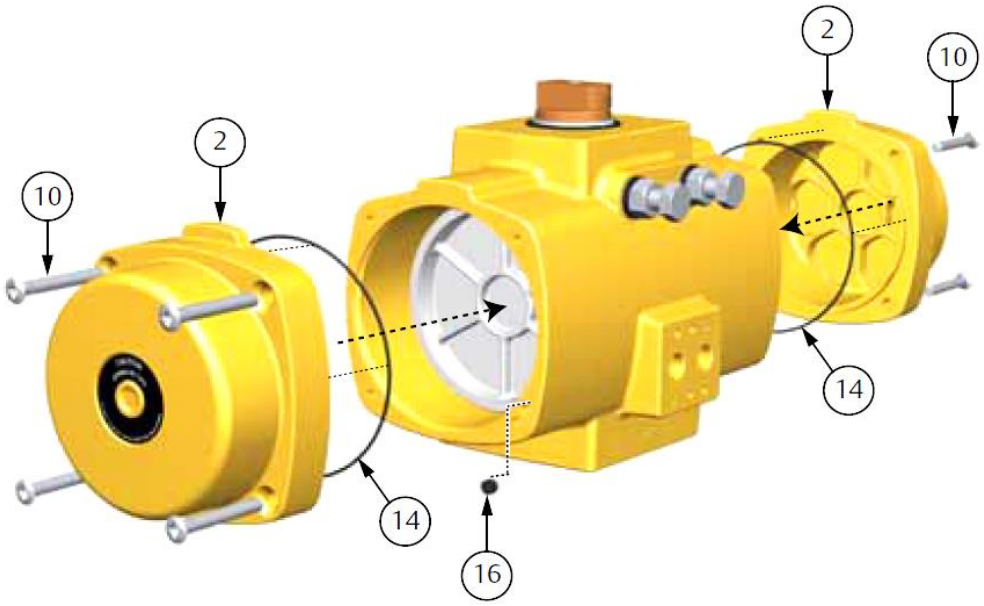
7.5.1. Double-Acting Actuators

7.5.1.1. Grease the O-ring seals (14) and B port seals (16) according to Section 7.1.

7.5.1.2. Ensure that the O-ring seals (14) and B port seals (16) remain in place during assembly. Refer to Figure 26.

7.5.1.3. Install the end caps (2) and tighten the end caps screws (10).

Figure 26: Double-Acting End Cap Assembly



- The above end caps (2) are for actuator sizes 0025, 0040, 0065, and 0100.
- End caps for actuator sizes 0150 and larger will have flat end caps (see far left).

7.5.2. Spring-Return Actuators

Important, when replacing the spring cartridges in a spring-return actuator, ensure that the cartridges are replaced in their identical position from where they were removed. Refer to Figure 27 for proper placement of spring cartridges in case of spring set conversion. Before assembling the spring cartridges and the end caps, make sure that the pistons are completely inwards.

Figure 27: Spring Cartridge Placement

A = Piston Top View
B = Position of Gear Rack

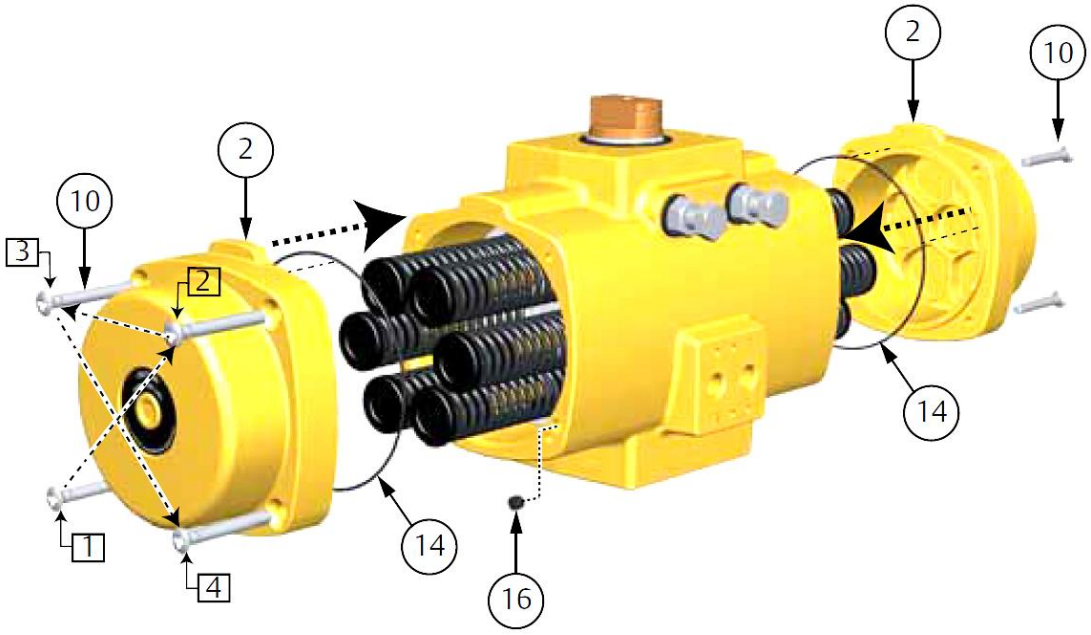
7.5.2.1. Grease the O-ring seals (14) and B port seals (16) according to Section 7.1. Refer to Figure 28.

7.5.2.2. Ensure that the O-ring seals (14) and B port seals are kept in place during assembly.

7.5.2.3. Place the spring cartridges in the actuator as per the required spring set (see Figure 27).

7.5.2.4. Tighten each end cap screw in small equal turns and in the sequence as per Figure 28. It is recommended to use some grease on the fasteners for easier fastening.

Figure 28: Spring-Return End Cap Assembly



7.6. Basic Function and Air Leak Test

7.6.1. Apply pressure (no more than 116psig/8bar max.) to ports A or B. Use some liquid leak detector (or soap suds) at the indicated points: around pinion top (1), pinion bottom (2), the end caps (3), and the limit stops (4). Refer to Figure 29.

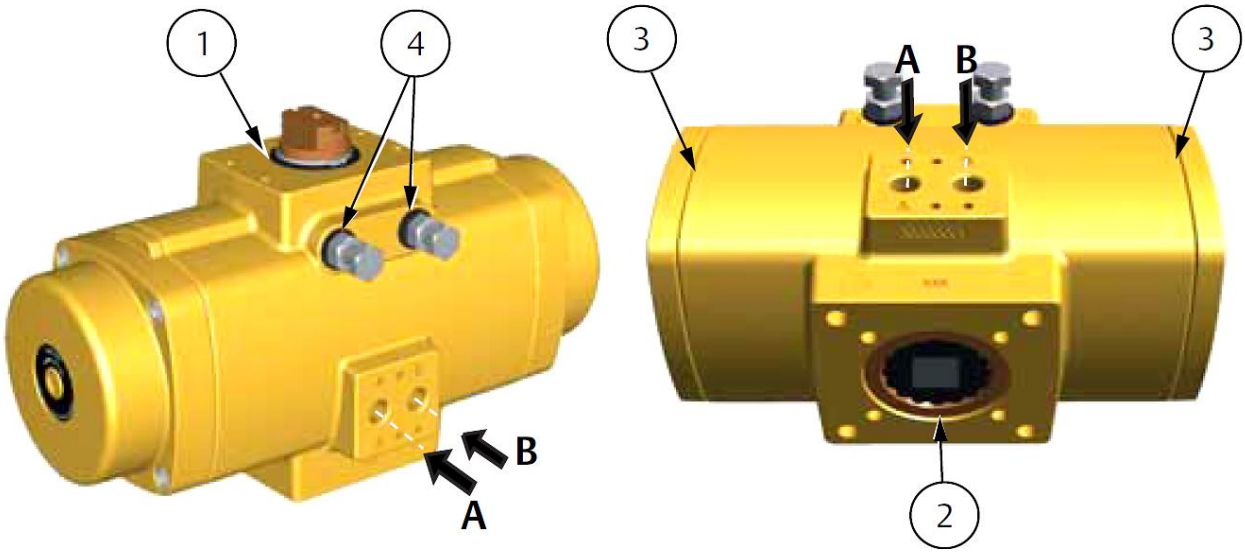
7.6.2. In case of leakage around:

A. The limit stops bolts (and/or the spring-package bolt on spring-return models). Turn the lock nut of the bolts tighter; until the leakage stops.

B. The end caps: disassemble the end caps, replace the O-rings, and reassemble.

C. The pinion top or bottom and A or B port: disassemble the complete actuator, replace O-rings, and reassemble.

Figure 29: Basic Function and Air Leak Test



8. Troubleshooting

8.1. Mechanical Problems

Problem	Possible Error	Solution	Where to Find
Feedback position and actual position are not the same.	Actuator and valve are mounted 90° rotated in relation to each other.	Remove actuator from valve. Check assembly code of actuator. Put both valve and actuator in "Closed" position. Mount actuator on valve.	Section 3.3 & 3.4
Valve is in "Closed" position, actuator is in "Open" position and will not move.			
Valve does not reach the completely "Closed" or "Open" position.	Limit stop screws are not set correctly.	Readjust the limit stop screws.	Section 3.5
	Insert is not mounted properly.	Mount the insert in the right position. Remark: Rotate insert to one cam = 22.5°.	Section 3.4
	Pressure too low.	Apply pressure as per sizing.	Section 1.5
	Sizing is wrong.	Check valve torque data with actuator torque data.	--
	Pinion is mounted in the wrong position.	Reassemble actuator.	Section 7
Actuator rotates, valve does not.	No coupling between actuator shaft and valve spindle.	Install a coupling between actuator shaft and valve spindle.	Section 3.4

8.2. Pneumatic Problems

Problem	Possible Error	Solution	Where to Find
Actuator does not react to electrical control signal.	There is no supply pressure at the actuator.	Supply the right pressure to the actuator.	Section 1.5. Check that the actual supply pressure is higher than the sizing pressure.
Actuator does not react to electrical control signal.	There is sufficient supply air pressure but insufficient supply air capacity.	Verify that the supply air tubing has the right dimensions.	Section 3.6
	Supply pressure too low, causing pilot operated solenoid valve to fail.	Check that supply pressure at the actuator and solenoid is sufficient to operate the actuator.	Section 1.5. Check that the actual supply pressure is higher than the sizing pressure.
	Solenoid valve is not mounted properly.	Check the solenoid valve mounting.	Instructions shipped with the solenoid valve.
	Speed control throttle (if present) blocks air flow.	Open the speed control throttle.	Instructions shipped with the speed control valve.
	Manual override (if present) on the solenoid valve is locked.	Unlock manual override on the solenoid valve.	Instructions shipped with the manual override.
Air leakage between actuator and solenoid valve.	Sealing between solenoid valve and actuator is not mounted air tight.	Reassemble solenoid valve taking care, that all seals are in place.	Instructions shipped with the solenoid valve.
Double-acting actuator will only move to “open” position.	Actuator has wrong solenoid valve configuration.	Mount a solenoid valve suitable for double-acting actuators (4/2 or 5/2 function).	Instructions shipped with the solenoid valve.
		Check that the conversion plate on the solenoid, that have both 3/2 & 5/2 functions, is in the correct position.	Instructions shipped with the solenoid valve.

8.3. Electrical Problems

Problem	Possible Error	Solution	Where to Find
Actuator does not react to control signals.	Control wiring. Power supply wiring or feedback wiring are not correctly connected.	Connect all wiring in the correct way.	Instructions of the control or feedback accessories.
	The power supply voltage is not the same as the voltage of the applicable solenoid valve.	Connect the correct power supply voltage.	Instructions of the solenoid valve.
There are no problems with position feedback after sending the actuator to either the “Open” or “Closed” position.	The wiring of the feedback signals may be switched.	Connect the feedback wiring in the correct way.	Instruction of the feedback device.

Appendix A: Spring Load Removal

This section explains how to remove the spring load of spring-return actuators safely in case of the following:

- The valve stops (or gets stopped) in the mid position.
- One of the spring cartridges is broken.

A spring-return actuator mounted on a valve, which is stuck in the mid stroke, contains a high spring load which will cause a sudden rotation of the actuator versus the valve spring during disassembly. This can cause serious injury to personnel or damage to material.

On spring-return actuators with a broken spring cartridge, the end caps can be ejected during disassembly of the actuator. This can cause serious injury to personnel or damage to material.

A.1 Spring Load Relief

⚠ CAUTION - ROTATING ACTUATOR

In case of an actuator/valve assembly stopped in mid position, leave the actuator on the valve and/or mounting bracket during this procedure.

Figure A-1: Spring Load Removal

1. Depressurize the actuator completely.
2. Based on the actuator size, choose the correct threaded rod kit from Table A-1.
3. Replace one by one, each end screw cap screw with the correct threaded rod and turn down the adjusting nut until it touches the end cap.
4. Once all four end cap screws have been replaced, gradually turn the adjustment nuts on the threaded rod in the counter-clockwise (CCW)

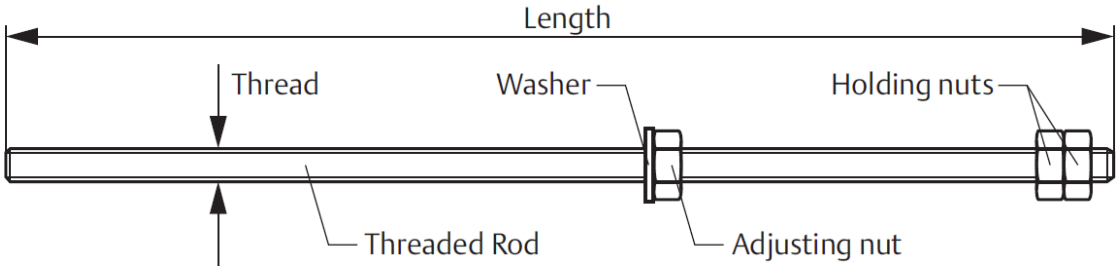
direction by turning the nuts half turn at a time. Make sure the rod itself does not turn. Continue until the load of the springs is relieved.

5. Repeat the same procedure for the end cap screws on the other side of the actuator.
6. In case of an actuator/valve assembly stopped in the mid position, the actuator now can be disassembled from the valve by removing the mounting hardware.

Table A-1: Threaded Rod Dimensions

Actuator Size	Rod Thread	Threaded Rod Length	
		mm	Inches
0012	M4	132	5.2
0025	M5	140	5.5
0040	M5	140	5.5
0065	M5	140	5.5
0100	M5	140	5.5
0150	M6	145	5.7
0200	M6	145	5.7
0350	M8	185	7.3
0600	M10	185	7.3
0950			
1600			
2500			
4000			

Figure A-2: Spring Load Removal Rod



Appendix B: Tool and Torque Table

This section lists the correct tool and necessary torque for the end cap fasteners.

Table B-1: End Cap Bolts

Actuator Size	Thread	Tool	Size	Torque (lbf-ft)			Torque (Nm)		
				Target	Min.	Max.	Target	Min.	Max.
0012	M4	Allen Key	SW 3	0.8	0.6	1.0	1.1	0.8	1.3
0025	M5	Phillips –H- Screwdriver	No. 2	1.5	1.2	2.2	2.0	1.6	3.0
0040	M5		No. 2	1.5	1.2	2.2	2.0	1.6	3.0
0065	M5		No. 2	1.5	1.2	2.2	2.0	1.6	3.0
0100	M5		No. 2	1.5	1.2	2.2	2.0	1.6	3.0
0150	M6		No. 3	2.4	1.9	3.8	3.3	2.6	5.1
0200	M6		No. 3	2.4	1.9	3.8	3.3	2.6	5.1
0350	M8		No. 4	6.2	4.9	9.0	8.4	6.7	12.2
0600	M10		No. 4	11.3	9.0	18.3	15.3	12.2	24.8
0950									
1600									
2500									
4000									