

Fisher® 657NS Diaphragm Actuators Size 40, 45, 70, and 80

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Introduction

Scope of Manual

This manual provides installation, maintenance, and parts list information for the Fisher 657NS actuator. Refer to separate instruction manuals for information regarding the control valve and accessories.

Do not install, operate, or maintain 657NS actuators without being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance. **To avoid personal injury or property damage, it is important to carefully read, understand, and follow all the contents of this manual, including all safety cautions and warnings.** If you have any questions about these instructions, contact your Emerson Process Management sales office before proceeding.

Description

The 657NS actuator is a direct-acting, spring-opposed diaphragm actuator used for operation of automatic control valves. The 657NS actuator yoke construction and special yoke-to-bonnet bolting provides a high structural resonant frequency that exceeds most nuclear service seismic requirements.



Table 1. Fisher 657NS Specifications

SPECIFICATION	ACTUATOR SIZE				
		40	45	70	80
Nominal Effective Area	cm ²	445	677	1419	see table 3
	Inch ²	69	105	220	see table 3
Yoke Boss Diameters	mm	71	71	90	5H
	Inch	2-13/16	2-13/16	3-9/16	5H
Acceptable Valve Stem Diameters	mm	12.7	12.7	19.1	25.4 & 31.8
	Inch	1/2	1/2	3/4	1 & 1-1/4
Maximum Allowable Output Thrust ⁽¹⁾	N	12,015	23,352	42,720	88,110
	Lb	2700	5250	9600	19,800
Maximum Travel	mm	38	51	76	76
	Inch	1.5	2	3	3
Maximum Casing Pressure for Actuator Sizing ⁽³⁾	Bar	4.5	3.4	3.8	4.9
	Psig	65	50	55	70
Maximum Diaphragm Casing Pressure ^(2, 3)	Bar	5.2	4.1	4.5	5.5
	Psig	75	60	65	80
Material Temperature Capabilities ⁽³⁾	-40 to 82°C (-40 to 180°F) with nitrile diaphragm				

1. Do not exceed maximum allowable valve stem load when applying maximum allowable thrust.
2. Maximum allowable diaphragm casing pressure may be used only when maximum allowable stem forces are not exceeded.
3. The pressure and temperature limitations in this manual, and any applicable code limitation, should not be exceeded.

Table 2. Diaphragm Casing Volumes, cm³ (Inch³)

ACTUATOR SIZE	CLEARANCE VOLUME, cm ³ (INCH ³)	TRAVEL, mm (INCH)						
		11 (0.4375)	16 (0.625)	19 (0.75)	29 (1.125)	38 (1.5)	51 (2)	76 (3)
40	934 (57)	1475 (90)	1704 (104)	1852 (113)	2327 (142)	2786 (170)	---	---
45	1556 (95)	---	2786 (170)	2999 (183)	3720 (227)	4424 (270)	5408 (330)	---
70	3490 (213)	5244 (320)	5948 (363)	6424 (392)	7833 (478)	9242 (564)	11,110 (678)	14,879 (908)
80	4818 (294)	---	---	---	10,488 (640)	12,454 (760)	14,863 (907)	19,337 (1180)

Table 3. Size 80 Diaphragm Area

TRAVEL	TRAVEL		AREA	
	mm	Inch	cm ²	Inch ²
0	0	0	2039	316
19	0.75	0.75	1903	295
29	1.125	1.125	1865	289
38	1.5	1.5	1845	286
51	2	2	1832	284
64	2.5	2.5	1800	279
76	3	3	1761	273

Table 4. Actuator Stem Assembly Bolt Torque Values

ACTUATOR SIZE	TORQUE	
	N•m	Lbf•Ft
40	108	80
45	271	200
70	271	200
80	542	400

Table 5. Bonnet-to-Actuator Bolt Torque Values

ACTUATOR SIZE	BONNET-ACTUATOR STUD BOLT TORQUE	
	N•m	Lbf•Ft
40	102	75
45	102	75
70	176	130
80	292	215

Specifications

Tables 1, 2, and 3 provide specifications for the various sizes of 657NS actuators discussed in this instruction manual. Specific actuator information is found on the actuator yoke nameplate.

⚠ WARNING

To avoid personal injury or property damage, do not exceed pressure and temperature limits specified in table 1.

Educational Services

For information on available courses for the Fisher 657NS diaphragm actuator, as well as a variety of other products, contact:

Emerson Process Management
Educational Services, Registration
P.O. Box 190; 301 S. 1st Ave.
Marshalltown, IA 50158-2823
Phone: 800-338-8158 or
Phone: 641-754-3771
FAX: 641-754-3431
e-mail: education@emerson.com

Installation

The diaphragm actuator is normally shipped mounted on a valve body. Follow the valve body instructions when installing the control valve in the pipeline.

⚠ WARNING

Always wear protective gloves, clothing, and eyewear when performing any installation operations to avoid personal injury.

Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

If installing into an existing application, also refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

⚠ WARNING

If the control valve and actuator are installed with the actuator in any position other than vertical, the actuator may not conform with safety-related qualifications. Nonvertical orientation should be part of existing qualification analysis on file at the plant site to ensure conformance with safety-related qualifications.

The control valve assembly normally may be installed in any orientation; however, the assembly must not be installed so that water can collect in the actuator yoke and lower diaphragm casing areas.

Note

The 657NS actuator will not mount on a standard valve bonnet; it requires a style NS bonnet having eight bonnet-to-yoke stud bolts.

If the actuator and control valve body are separate, mount the 657NS actuator on the valve body by following the procedures in the Actuator Mounting section of this manual.

Actuator Mounting

Direct-Acting (Push-Down-to-Close) Valves

See figure 1.

1. Screw the stem locknuts all the way onto the valve stem. Put the travel indicator disk, not used with the size 80 actuator, on the stem locknuts. The concave side of the disk should face the valve.
2. Push the valve stem down to close the valve.
3. Lift or hoist the actuator onto the valve bonnet.
4. Insert the cap screws and tighten the hex nuts (not shown), securing the actuator to the bonnet. Tighten the cap screws to the torque shown in table 5.
5. Thread the spring adjustor (see figure 1 for sizes 40 through 70 and key 12, figure 4 for size 80) until the actuator is at the full up position.
6. With the travel indicator scale attached to the actuator yoke, make a temporary mark on the actuator stem at a point parallel with the top mark on the travel indicator scale. This is the fully open position.
7. Refer to the actuator nameplate to determine the bench set pressure range of the actuator. Apply the lower bench set pressure to the actuator, and turn the spring adjustor until the actuator stem mark is even with the top mark on the travel indicator scale.
8. Apply the higher bench set pressure to the actuator. Verify that the mark on the actuator stem is even with the bottom mark on the travel indicator scale. This is the fully closed position. The distance from the top mark on the scale to the bottom mark is equal to the travel of the valve.

If the marks are in line, the actuator is properly bench set.

If the marks are not in line, the spring is not correct for the specified bench set. It is necessary to use a different spring or a different bench set.

⚠ WARNING

To avoid personal injury due to the sudden uncontrolled movement of parts, do not loosen the cap screws when the stem connector has spring or loading pressure force applied to it.

CAUTION

Incomplete engagement of the valve stem and/or actuator stem in the stem connector can result in stripped threads or improper operation. Be sure that the length of each stem clamped in the stem connector is equal to or greater than the diameter of that stem.

Note

Replacement stem connectors are an assembly of two stem connector halves, cap screws, and a spacer between the connector halves. Remove the spacer, if present, before clamping the stems together.

9. Push the valve stem firmly against its seat, and be sure that it remains firmly against the seat. Clamp the actuator stem and valve stem between the two stem connector halves. If necessary, increase loading pressure slightly to allow the valve stem, actuator stem, and stem connector threads to match.

Insert and tighten the stem connector cap screws.

10. Raise the travel indicator disk to the stem connector (for sizes 40 through 70). For all sizes, thread the stem locknuts against the stem connector.
11. Remove all loading pressure. Move the travel indicator scale so that the indicator disk (or pointer) is in line with the top mark of the travel indicator scale.
12. Check the valve travel to be sure that the valve travels fully with no overtravel.

Reverse-Acting (Push-Down-to-Open) Valves

See figure 1.

1. Screw the stem locknuts all the way onto the valve stem. Put the travel indicator disk (not used with the size 80 actuator) on the stem locknuts. The concave side of the disk should face the valve.
2. Push the valve stem down to open the valve.
3. Lift or hoist the actuator onto the valve bonnet.
4. Insert the cap screws and tighten the hex nuts (not shown), securing the actuator to the bonnet. Tighten the cap screws to the torque shown in table 5.
5. Apply actuator loading pressure until the actuator is at the full down position.
6. With the travel indicator scale attached to the actuator yoke, make a temporary mark on the actuator stem at a point parallel with the bottom mark on the travel indicator scale. This is the fully open position.
7. Refer to the actuator nameplate to determine the bench set pressure range of the actuator. Apply the lower bench set pressure to the actuator. Turn the spring adjuster until the actuator stem mark is even with the top mark on the travel indicator scale.
8. Apply the higher bench set pressure to the actuator and verify that the mark on the actuator stem is even with the bottom mark on the travel indicator scale. This is the fully-open position. The distance from the top mark on the scale to the bottom mark is equal to the travel of the valve.

If the marks are in line, the actuator is properly bench set.

If the marks are not in line, the spring is not correct for the specified bench set. It is necessary to use a different spring or a different bench set.

⚠ WARNING

To avoid personal injury due to the sudden uncontrolled movement of parts, do not loosen the cap screws when the stem connector has spring or loading pressure force applied to it.

CAUTION

Incomplete engagement of the valve stem and/or actuator stem in the stem connector can result in stripped threads or improper operation. Be sure that the length of each stem clamped in the stem connector is equal to or greater than the diameter of that stem.

Note

Replacement stem connectors are an assembly of two stem connector halves, cap screws, and a spacer between the connector halves. Remove the spacer, if present, before clamping the stems together.

9. Reduce loading pressure until the temporary mark on the actuator stem is parallel with the top mark on the indicator scale.
10. Pull the valve stem firmly against its seat, and be sure that it remains firmly against the seat. Clamp the actuator stem and valve stem between the two stem connector halves. If necessary, increase loading pressure slightly to allow the valve stem, actuator stem, and stem connector threads to match.

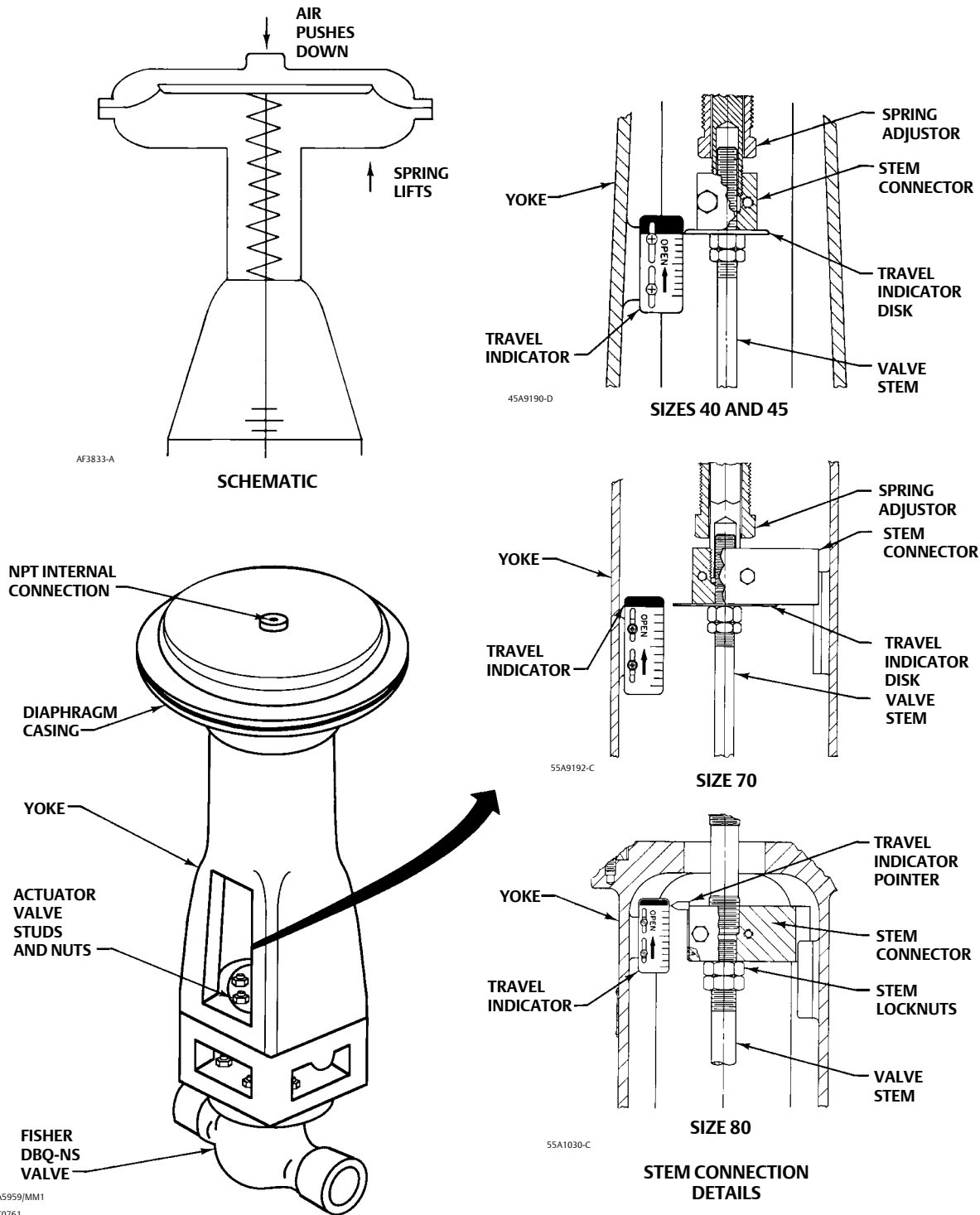
Insert and tighten the stem connector cap screws.

11. Raise the travel indicator disk to the stem connector (sizes 40 through 70 only). For all sizes, thread the stem locknuts against the stem connector.
12. Remove all loading pressure. Move the travel indicator scale so that the indicator disk (or pointer) is in line with the top mark of the travel indicator scale.
13. Check the valve travel to be sure that the valve travels fully with no overtravel.

Loading Connection

1. Connect the loading pressure piping to the NPT internal connection in the top of the actuator yoke.
2. For size 70 actuators, remove the 1/4-inch bushing in the 1/2 NPT internal connection to increase connection size, if necessary. The connection can be made with either piping or tubing.
3. Keep the length of tubing or piping as short as possible to avoid transmission lag in the control signal. If a volume booster, valve positioner or other accessory is used, be sure that it is properly connected to the actuator. Refer to the positioner instruction manual as necessary.
4. Cycle the actuator several times to check that the valve stem travel is correct and that the travel occurs when the correct pressure range is applied to the diaphragm.
5. If valve stem travel is incorrect, refer to the Travel procedure in the Adjustments section.
6. If the pressure range is incorrect, refer to the Spring procedure in the Adjustments section.

Figure 1. Schematic and Stem Connection Details for Fisher 657NS



Adjustments

Travel

⚠ WARNING

When moving the actuator stem with diaphragm loading pressure, use caution to keep hands and tools out of the actuator stem travel path. Personal injury and/or property damage is possible if something is caught between the actuator stem and other control valve assembly parts.

Make travel adjustments when the motion observed during actuator travel is different from the travel stamped on the actuator nameplate. If the Actuator Mounting procedure was followed correctly, this adjustment should not be necessary.

When adjusting travel of a reverse-acting (push-down-to-open) valve, apply sufficient loading pressure to move the valve plug off of the seat. This procedure reduces the chance of damaging the valve plug or seat during adjustments.

1. Back the stem locknuts and travel indicator disk away from the stem connector, and slightly loosen the stem connector cap screws.

CAUTION

Do not use wrenches or other tools directly on the valve stem. Damage to the stem surface and subsequent damage to the valve packing might result.

2. Tighten the locknuts together using a wrench, then screw the valve stem either into the stem connector to lengthen travel or out of the stem connector to shorten travel.
3. Cycle the actuator to check the travel. If actual travel is not equal to the specified travel, adjust and check travel until correct. Tighten the stem connector cap screws when correct travel is obtained.
4. Raise the travel indicator disk by threading the stem locknuts against the stem connector.

Spring

Bench Set

The bench set pressure range is used to adjust the initial compression of the actuator spring with the actuator assembly “on the bench”. The correct initial compression ensures that the valve-actuator assembly will function properly when it is put in service and the proper actuator diaphragm operating pressure is applied.

The bench set range is established with the assumption that there is no packing friction. When attempting to adjust the spring in the field, it is very difficult to ensure that there is no friction being applied by “loose” packing.

Accurate adjustment to the bench set range can be made during the actuator mounting process (see the Actuator Mounting procedure) by making the adjustment before the actuator is connected to the valve.

If you are adjusting to the bench set range after the actuator is connected to the valve and the packing tightened, you must take friction into account. Make the spring adjustment such that full actuator travel occurs at the bench set range (a) plus the friction force divided by the effective diaphragm area with increasing diaphragm pressure or (b) minus the friction force divided by the effective diaphragm area with decreasing diaphragm pressure.

For an assembled valve-actuator assembly, determine valve friction as described below:

1. Install a pressure gauge in the supply pressure line that connects to the actuator diaphragm casing.
2. Increase the actuator diaphragm pressure. Record the diaphragm pressure as the actuator reaches its mid-travel position.
3. Increase the actuator diaphragm pressure until the actuator is at a travel position greater than its mid-travel position.
4. Decrease the actuator diaphragm pressure. Record the diaphragm pressure as the actuator reaches its mid-travel position.

The difference between the two diaphragm pressure readings is the change in the diaphragm pressure required to overcome the friction forces in the two directions of travel.

5. Calculate the actual friction force:

$$\text{Friction Force, pounds} = 1/2 \left(\begin{array}{l} \text{Difference} \\ \text{in pressure} \\ \text{readings, psig} \end{array} \right) \times \left(\begin{array}{l} \text{Effective} \\ \text{diaphragm area,} \\ \text{inches}^2 \end{array} \right)$$

Refer to table 1 and 3 for the effective diaphragm area.

When determining valve friction, you can make diaphragm pressure readings at a travel position other than mid-travel if you desire. If you take readings at the zero or at the full travel position, ensure that the readings are taken when the travel just begins or just stops at the position selected.

The spring adjustor is difficult to rotate. Release the loading pressure before adjusting, then re-apply loading pressure to check the adjustment.

Bench Set Adjustments

1. Monitor loading pressure carefully when making adjustments. Do not exceed the maximum pressure specifications of either the loading regulator or the actuator casings (refer to table 1 for Maximum Diaphragm Casing Pressure).
2. Each actuator spring has a fixed pressure span. Changing the spring compression shifts the span up or down to make valve travel coincide with the loading pressure range.
3. For sizes 40 through 70, turn the spring adjustor (key 12, figure 2 or 3) into the yoke to shift the span up or turn the spring adjustor out of the yoke to shift the span down. For size 80, remove the spring case assembly (key 35, figure 4) by removing the cap screws (key 6, figure 4). Then rotate the spring adjustor (key 12, figure 4) to shift the span. Replace the spring case assembly and screws.

If the actuator has a side-mounted handwheel assembly, turn the handwheel clockwise to close the valve.

For successful operation, the actuator stem and valve plug stem must move freely in response to the loading pressure change on the diaphragm.

Operation

In a direct-acting diaphragm actuator, an increasing loading pressure causes the actuator stem to move downward, compressing the spring. When the diaphragm pressure is decreased, the spring moves the actuator stem upward. This

is shown graphically in figure 1. In the event of failure of the loading pressure to the diaphragm of the actuator, the actuator stem moves to the extreme upward position. Thus, by the proper selection of the valve plug action, either push-down-to-close or push-down-to-open, the control valve will either close or open on failure of the loading pressure.

The nameplate attached to the yoke of the actuator provides information about the specific construction and operating range. The spring and diaphragm have been selected to meet the requirements of the application, and in service, the actuator should create full travel of the valve plug when the diaphragm pressure (operate) range indicated on the nameplate is applied. This diaphragm pressure range is generally 0.2 to 1.0 bar or 0.4 to 2.0 bar (3 to 15 psi or 6 to 30 psi).

Pressure in the valve body creates a force on the valve plug that has a direct effect on the actual operating diaphragm pressure range. In some instances, the valve may not stroke completely over the indicated range because the pressure conditions in the body are different from those for which the control valve has been set at the factory. A simple spring adjustment, however, may be all that is required to obtain correct travel for the diaphragm pressure range utilized. Note that the actuator spring has a fixed pressure span and that adjustment of the spring compression merely shifts this span up or down to make valve travel coincide with the diaphragm pressure range.

The nameplate specifies a bench set pressure range in addition to a diaphragm pressure (operate) range. The bench set range is that pressure range required to stroke the valve fully without any pressure in the body, as would be the case if the valve were set on the work bench. However, in service, with the specified pressure drop applied across the valve, it should stroke over the diaphragm pressure (operate) range indicated on the nameplate.

When the control valve and actuator are installed, the actuator should be checked for correct travel, freedom from excessive friction, and correct action (air-to-open or air-to-close) to match the controlling instrument. For successful operation, the actuator stem and the valve plug stem must move freely in response to the loading pressure change on the diaphragm.

Maintenance

Normally, only the elastomeric parts and the spring of the 657NS actuator require inspection or replacement. The maintenance instructions are divided into three subsections: Replacement of the Elastomeric Parts, Disassembly, and Assembly. Perform only those steps applicable to the actuator size and required maintenance.

All maintenance operations can be performed with the valve in the line.

It is recommended that the diaphragm and all of the other elastomeric parts of the 657NS actuator be inspected every two years. The absolute maximum replacement period for any of the elastomeric parts is four years.

▲ WARNING

Avoid personal injury or property damage from sudden release of process pressure or bursting of parts. Before performing any maintenance operations:

- **Do not remove the actuator from the valve while the valve is still pressurized.**
- **Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.**
- **Vent the power actuator loading pressure and relieve any actuator spring precompression.**

- Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.
 - The valve packing box may contain process fluids that are pressurized, *even when the valve has been removed from the pipeline*. Process fluids may spray out under pressure when removing the packing hardware or packing rings, or when loosening the packing box pipe plug.
 - Check with your process or safety engineer for any additional measures that must be taken to protect against process media.
-

Replacement of the Elastomeric Parts

Size 40, 45, and 70 Actuators

Perform the following if it is desired to replace only the elastomeric parts of the 657NS actuator, and no other maintenance is necessary. The diaphragm is the only elastomeric part in the size 40, 45, and 70 actuators. Key number references are shown in figure 2 for size 40 and 45 actuators and in figure 3 for size 70 actuators.

1. Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. Reduce the actuator loading pressure to atmospheric pressure, and remove the tubing or piping from the top of the upper diaphragm casing (key 1).
2. Remove the diaphragm casing cap screws and nuts (keys 22 and 23), and lift off the upper diaphragm casing.
3. Take out the diaphragm (key 2), and install a new one.

Note

When you replace actuator diaphragms in the field, take care to ensure the diaphragm casing cap screws are tightened to the proper load to prevent leakage, but not crush the material. Perform the following tightening sequence with a manual torque wrench for size 40, 45, and 70 actuators.

CAUTION

Overtightening the diaphragm casing cap screws and nuts (keys 22 and 23) can damage the diaphragm. Do not exceed a torque of 27 N•m (20 lbf•ft) when performing this tightening procedure.

Note

Do not use lubricant on these cap screws and nuts. Fasteners must be clean and dry.

4. Place the upper diaphragm casing (key 1) into position, and replace the diaphragm casing cap screws and nuts (keys 22 and 23). Tighten the hex nuts (key 23) in the following manner. The first four hex nuts tightened should be diametrically opposed and 90 degrees apart. Tighten these four hex nuts to 13 N•m (10 lbf•ft).
5. Tighten the remaining hex nuts in a clockwise, crisscross pattern to 13 N•m (10 lbf•ft).
6. Repeat this procedure by tightening four hex nuts, diametrically opposed and 90 degrees apart, to a torque of 27 N•m (20 lbf•ft).
7. Tighten the remaining hex nuts in a clockwise, crisscross pattern to 27 N•m (20 lbf•ft).

8. After the last bolt is tightened to 27 N•m (20 lbf•ft), all of the bolts should be tightened again to 27 N•m (20 lbf•ft) in a circular pattern around the bolt circle.
9. Once completed, no more tightening is recommended.
10. Replace the tubing or piping to the top of the upper diaphragm casing.

Size 80 Actuators

The elastomeric parts in a size 80 actuator include the diaphragm and O-rings. Since replacement of these parts necessitates complete disassembly, perform the steps outlined in Size 80 Actuators, disassembly and assembly procedures.

Disassembly

Size 40, 45, and 70 Actuators

Key number references are shown in figure 2 for size 40 and 45 actuators and in figure 3 for size 70 actuators.

1. Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. Reduce the actuator loading pressure to atmospheric pressure, and remove the tubing or piping from the top of the upper diaphragm casing (key 1).
2. To aid in assembly, record the position of the spring adjusting screw (key 12) relative to the actuator yoke (key 9). Loosen the spring adjusting screw locking set screw (key 67), and thread the adjusting screw out of the yoke until all spring compression is relieved.
3. If necessary, remove the actuator from the valve body by separating the stem connector (key 26) and removing the eight bonnet stud bolt nuts. Separate the stem connector by loosening the stem hex nuts (keys 15 and 16) and unscrewing the two cap screws.
4. Remove the diaphragm casing cap screws and nuts (keys 22 and 23), and lift off the upper diaphragm casing (key 1).
5. Take out the molded diaphragm (key 2).
6. The diaphragm plate and actuator stem (keys 4 and 10) can be taken out of the yoke as an assembly. This assembly can be further disassembled, if desired, by removing the cap screw (key 3).
7. Take out the actuator spring (key 6) and the lower spring seat (key 11).
8. The lower diaphragm casing (key 5) can be removed from the yoke, if required, by removing the cap screws (key 8) that hold the lower diaphragm casing in place.
9. Unscrew the adjusting screw (key 12) from the yoke to complete the disassembly. Be careful not to lose the straight pin (key 89) since it could drop out of the yoke through the threaded adjusting screw hole.

Size 80 Actuators

Key number references are shown in figure 4.

1. Bypass the control valve. Reduce the actuator loading pressure to atmospheric pressure, and remove the piping or tubing from the upper diaphragm casing connection.
2. Loosen the hex nut (key 50), and back the adjustable travel stop (key 34) away from the diaphragm casings (keys 1 and 5).
3. Unbolt the cap screws (key 8), and remove the spring case assembly (key 35).
4. Measure and record how much of the actuator stem (key 10) extends past the spring adjusting screw (key 12). Using a hammer and a punch, loosen the spring adjusting screw locknut (key 91). Slip a 12.7 mm (1/2-inch)

diameter rod into a hole in the spring adjusting screw (key 12). Using the rod, turn the spring adjusting screw away from the diaphragm (key 2) to relieve all compression in the spring (key 6).

- Loosen the hex nuts (key 16), and remove the stem connector cap screws and stem connector halves (key 26). If necessary, the actuator may be removed from the valve body by removing the valve bonnet stud bolt hex nuts.
- Remove the spring adjusting screw (key 12), the spring seat guide (key 36), the lower spring seat (key 11), and the spring seat bearing and race (keys 41 and 42).
- Remove the actuator spring (key 6) and the spring adjusting screw locknut (key 91).
- Unbolt the diaphragm casing cap screws and hex nuts (keys 22 and 23), and lift the upper diaphragm casing (key 1) and attached casing flange (key 51) with seal bushing (key 46) straight up until clear of the actuator stem (key 10).
- Remove the snap ring (key 47) and slide the seal bushing (key 46) out of the casing flange (key 51). Inspect the seal bushing for wear, and replace if necessary. Remove the seal bushing O-rings (keys 44 and 45). Separate the casing flange (key 51) from the upper diaphragm casing (key 1) by removing the cap screws (key 8). Remove the gasket (key 52) from the upper diaphragm casing (key 1).
- Slide or lift the actuator stem (key 10) with the attached diaphragm plates and diaphragm (key 48, 4, and 1) out of the actuator.
- To aid in unscrewing the hex nuts (key 49), attach the stem connector assembly (key 26) onto the actuator stem and grip the stem connector in a vise. This procedure will help secure the actuator stem and help prevent damage.
- Unscrew the hex nuts (key 49), and slide them, the diaphragm plate (key 4), diaphragm (key 2), and upper diaphragm plate (key 48) off the actuator stem.
- Remove the cap screws (key 8) that secure the lower diaphragm casing (key 5) to the actuator yoke (key 9), and remove the lower casing.

Assembly

Size 40, 45, and 70 Actuators

Key number references are shown in figure 2 for size 40 and 45 actuators and in figure 3 for size 70 actuators.

- Apply lithium grease to the threads and spring seat bearing surface of the adjusting screw. Thread the adjusting screw (key 12) into the yoke (key 9).
- Use the cap screws (key 8) to attach the lower diaphragm casing (key 5) to the yoke. Tighten the cap screws to 41 N•m (30 lbf•ft) for sizes 40 and 45 and 102 N•m (75 lbf•ft) for the size 70.
- Insert the lower spring seat (key 11) and spring (key 6) into the yoke. Be sure the spring seat fits squarely on the adjusting screw and that the spring is properly seated in the spring seat.
- Assemble the actuator stem (key 10) and the diaphragm plate (key 4) with the cap screw and washer (key 3 and 25). Tighten the cap screw in accordance with table 4. The size 40 actuator does not use a washer.
- Insert the stem and diaphragm plate as an assembly, making sure that the stem fits inside the adjusting screw and that the spring fits squarely on the diaphragm plate.
- Install a new diaphragm (key 2) if one is required. Otherwise, replace the molded diaphragm (key 2) onto the diaphragm plate so that the molded edge points outward toward the spring (see figures 2 and 3) and the word Fisher printed on the diaphragm is visible. Line up the holes in the diaphragm's edge with the diaphragm casing cap screw holes.

Note

When you replace actuator diaphragms in the field, take care to ensure the diaphragm casing cap screws are tightened to the proper load to prevent leakage, but not crush the material. Perform the following tightening sequence with a manual torque wrench for size 40, 45, and 70 actuators.

CAUTION

Overtightening the diaphragm casing cap screws and nuts (keys 22 and 23) can damage the diaphragm. Do not exceed a torque of 27 N•m (20 lbf•ft) when performing this tightening procedure.

Note

Do not use lubricant on these cap screws and nuts. Fasteners must be clean and dry.

7. Place the upper diaphragm casing (key 1) into position, and replace the diaphragm casing cap screws and nuts (keys 22 and 23). Tighten the hex nuts (key 23) in the following manner. The first four hex nuts tightened should be diametrically opposed and 90 degrees apart. Tighten these four hex nuts to 13 N•m (10 lbf•ft).
8. Tighten the remaining hex nuts in a clockwise, crisscross pattern to 13 N•m (10 lbf•ft).
9. Repeat this procedure by tightening four hex nuts, diametrically opposed and 90 degrees apart, to a torque of 27 N•m (20 lbf•ft).
10. Tighten the remaining hex nuts in a clockwise, crisscross pattern to 27 N•m (20 lbf•ft).
11. After the last bolt is tightened to 27 N•m (20 lbf•ft), all of the bolts should be tightened again to 27 N•m (20 lbf•ft) in a circular pattern around the bolt circle.
12. Once completed, no more tightening is recommended.
13. Thread the spring adjusting screw (key 12) into the yoke so that it is in the same position recorded during disassembly. Securely tighten the locking set screw (key 67).
14. Replace the tubing or piping to the top of the upper diaphragm casing. Mount the actuator, and make the stem connection by following the procedures in the Actuator Mounting section.

Size 80 Actuators

Key number references are shown in figure 4.

1. Place the lower diaphragm casing (key 5) on the actuator yoke (key 9), and secure them together with the cap screws (key 8). Torque the screws evenly to 102 N•m (75 lbf•ft) using a crisscross pattern.
2. Carefully slide the upper diaphragm plate (key 48), the diaphragm (key 2), and the diaphragm plate (key 4) onto the actuator stem (key 10). Thread the two hex nuts (key 49) lightly against the diaphragm plate. To aid in tightening the hex nuts (key 49), attach the stem connector assembly (key 26) onto the actuator stem, and grip the stem connector in a vise. Tighten the first hex nut (key 49) to approximately 542 N•m (400 lbf•ft) torque. Tighten the second hex nut securely against the first. Remove the actuator stem subassembly from the vise, and remove the stem connector assembly (key 26) from this subassembly.
3. Place the actuator stem and attached parts into the lower diaphragm casing (key 5). Prop the stem up so that the diaphragm plates are positioned as shown in figure 4.
4. Lubricate the O-rings (keys 44 and 45) and the inside diameter of the seal bushing (key 46) with either a high-temperature, radiation-resistant, polyphenyl ether grease or lithium grease, as appropriate for the installation. Place the seal bushing and O-rings in the casing flange (key 51), and secure the bushing with the snap ring (key 47). Place a new gasket (key 52) and then the casing flange (key 51) onto the upper diaphragm casing (key 1). Insert and tighten the cap screws (key 8) to 102 N•m (75 lbf•ft) torque to secure the parts.
5. Align the diaphragm cap screw holes with the lower diaphragm casing cap screw holes. Slide the upper diaphragm casing and casing flange (keys 1 and 51) over the actuator stem (key 10) and onto the lower diaphragm casing (key 5) so that all cap screw holes are aligned.

Table 6. Size 80 Casing Cap Screw Torque Values

DIAPHRAGM MATERIAL	INITIAL TORQUE	FINAL TORQUE
	N•m (lbf•ft)	N•m (lbf•ft)
EPDM / Meta-Aramid	41 (30)	82 ± 13 (60 ± 10)
Nitrile, Silicone, FKM/Meta-Aramid	34 (25)	68 (50)

Note

When you replace actuator diaphragms in the field, take care to ensure the diaphragm casing cap screws are tightened to the proper load to prevent leakage, but not crush the material. Perform the following tightening sequence with a manual torque wrench for size 80 actuators.

CAUTION

Overtightening the diaphragm casing cap screws and nuts can damage the diaphragm. Do not exceed the following maximum torque values for the appropriate diaphragm material: EPDM/Meta-Aramid: 95 N•m (70 lbf•ft); Nitrile, Silicone, FKM (fluorocarbon) / Meta-Aramid: 68 N•m (50 lbf•ft).

Note

Do not use lubricant on these cap screws and nuts. Fasteners must be clean and dry.

6. Fasten the two diaphragm casings together with the cap screws (key 22) and tighten the hex nuts (key 23) in the following manner. The first four hex nuts tightened should be diametrically opposed and 90 degrees apart. Tighten these four hex nuts to the initial torque value found in table 6 for the diaphragm material being used.
7. Tighten the remaining hex nuts in a clockwise, crisscross pattern to the initial torque value found in table 6 for the diaphragm material being used.
8. Repeat this procedure by tightening four hex nuts, diametrically opposed and 90 degrees apart, to the final torque value that is specified in table 6 for the diaphragm material being used.
9. Tighten the remaining hex nuts in a clockwise, crisscross pattern to the final torque value that is specified in table 6 for the diaphragm material being used.
10. After the last hex nut is tightened, complete another tightening sequence. Tighten in a circular pattern around the bolt circle to the final torque value that is specified in table 6 for the diaphragm material being used.
11. Once completed, no more tightening is recommended.
12. Thread the spring adjusting screw locknut (key 91) onto the actuator stem (key 10). Place the spring (key 6) on the casing flange (key 51).
13. Assemble the spring seat and spring seat guide (keys 11 and 36). Place them on the actuator spring (key 6).
14. Lubricate the spring seat race and bearings (keys 39 and 40) with lithium grease (key 53). Place them on the spring seat.
15. Attach the stem connector (key 26) to the actuator stem so that the connector engages the antirotation guide on the actuator yoke. Thread the adjusting screw (key 12) onto the actuator stem until the actuator stem (key 10) extends above the adjusting screw the distance recorded in step 4 of the disassembly procedures for size 80 actuators. Securely tighten the spring adjusting screw locknut (key 91) against the spring adjusting screw (key 12).
16. Connect piping or tubing to the pressure connection in the upper diaphragm casing (key 1). Pressure the actuator, and if necessary, readjust the spring compression with the adjusting screw (key 12) until the actuator fully strokes over the bench set pressure range stamped on the actuator nameplate. Remove the stem connector.

17. Lubricate the spring seat guide (key 36) and the appropriate area inside the spring case assembly (key 35) with either a high-temperature, radiation-resistant, polyphenyl ether grease or lithium grease (key 54), as appropriate for the installation.
18. Place the spring case assembly (key 35) on the upper diaphragm casing. Insert and tighten the cap screws (key 8) to 102 N•m (75 lbf•ft).
19. Thread the adjustable travel stop (key 34) into the spring case (key 35) so that the travel stop is approximately 3.2 mm (1/8-inch) from the actuator stem (key 10) when the stem is in the extreme upward position. Thread the hex locknut (key 50) against the spring case, and lock it securely against the spring case.
20. Mount the actuator, and make the stem connection by following the procedure in the Actuator Mounting section.

Parts Ordering

Each actuator has a serial number stamped on the nameplate. Always refer to this serial number when corresponding with your Emerson Process Management sales office regarding replacement parts or technical information.

▲ WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson Process Management should not, under any circumstances, be used in any Fisher valve, because they may void your warranty, might adversely affect the performance of the valve, and could cause personal injury and property damage.

Parts List

Key	Description
1	Upper Diaphragm Casing, steel Std Size 40, 45, 70, and 80 W/top-mounted handwheel Size 40, 45, and 70
2*	Diaphragm, nitrile Std Size 40, 45, 70, and 80 W/adj travel stop Size 40, 45, and 70
3	Cap Screw, steel Size 40, 45, and 70
4	Diaphragm Plate, steel Size 40, 45, 70, and 80
5	Lower Diaphragm Casing, zn pl steel Size 40, 45, 70, and 80
6	Spring, steel
8	Cap Screw, steel Size 40 (6 req'd) Size 45 (8 req'd) Size 70 (12 req'd) Size 80 (36 req'd)
9	Yoke, steel Size 40, 45, 70, and 80
10	Actuator Stem, pl steel Size 40, 45, and 70 Size 80
11	Lower Spring Seat, steel Size 40, 45, 70, and 80
12	Adjusting Screw, pl steel Size 40, 45, 70, and 80
13	Lower Diaphragm Plate, steel Size 40, 45, and 70
14	Indicator Disc, stainless steel Size 40, 45, 70, and 80
15	Hex Nut, pl steel Size 40 and 70
16	Hex Nut, pl steel Size 40 Size 45 (2 req'd) Size 70 Size 80 (2 req'd)
17	Machine Screw, stainless steel (2 req'd) Size 40, 45, 70, and 80
18	Indicator Scale, stainless steel
19	Nameplate, stainless steel
20	Drive Screw, stainless steel (4 req'd)
22	Cap Screw, pl steel Size 40 (16 req'd) Size 45 (20 req'd) Size 70 (28 req'd) Size 80 (36 req'd)

Key	Description
23	Hex Nut, pl steel Size 40 (16 req'd) Size 45 (20 req'd) Size 70 (28 req'd) Size 80 (36 req'd)
24	Twin Speed Nut, stainless steel Size 70 only
25	Washer, steel Size 45 and 70
26	Stem Connector Assembly, stainless steel
28	Machine Screw, pl carbon steel (2 req'd) Size 80 only
32	Washer, steel (2 req'd) Size 70 only
33	Pipe Bushing, pl steel Size 70 only

Note

Key numbers 34 through 52 are for size 80 only.

34	Adjustable Travel Stop, steel
35	Spring Case Assembly, steel
36	Spring Seat Guide, brass
37	Bearing Retainer, steel
38	Shoulder Screw, pl steel
39	Travel Stop Bearing, steel
40	Travel Stop Race, steel (2 req'd)
41	Spring Seat Bearing, steel
42	Spring Seat Race, steel (2 req'd)
43	Vent Assembly
44*	O-Ring, fluoroelastomer (2 req'd)
45*	O-Ring, fluoroelastomer
46	Seal Bushing, brass
47	Snap Ring, stainless steel
48	Upper Diaphragm Plate, steel
49	Hex Nut, steel (2 req'd)
50	Hex Nut, steel
51	Casing Flange, steel
52*	Gasket, composition
53	Lithium grease (not furnished with actuator)
54	Lubricant (Size 80 only) (not furnished with actuator) Radiation Service High-temperature, radiation-resistant, polyphenyl ether grease Other Service Lithium grease
67	Set Screw, carbon steel
89	Straight Pin, brass Size 40, 45, and 70
91	Locknut, pl steel (Size 80 only)
242	Warning Nameplate

Figure 2. Size 40 or 45 Fisher 657NS Actuator

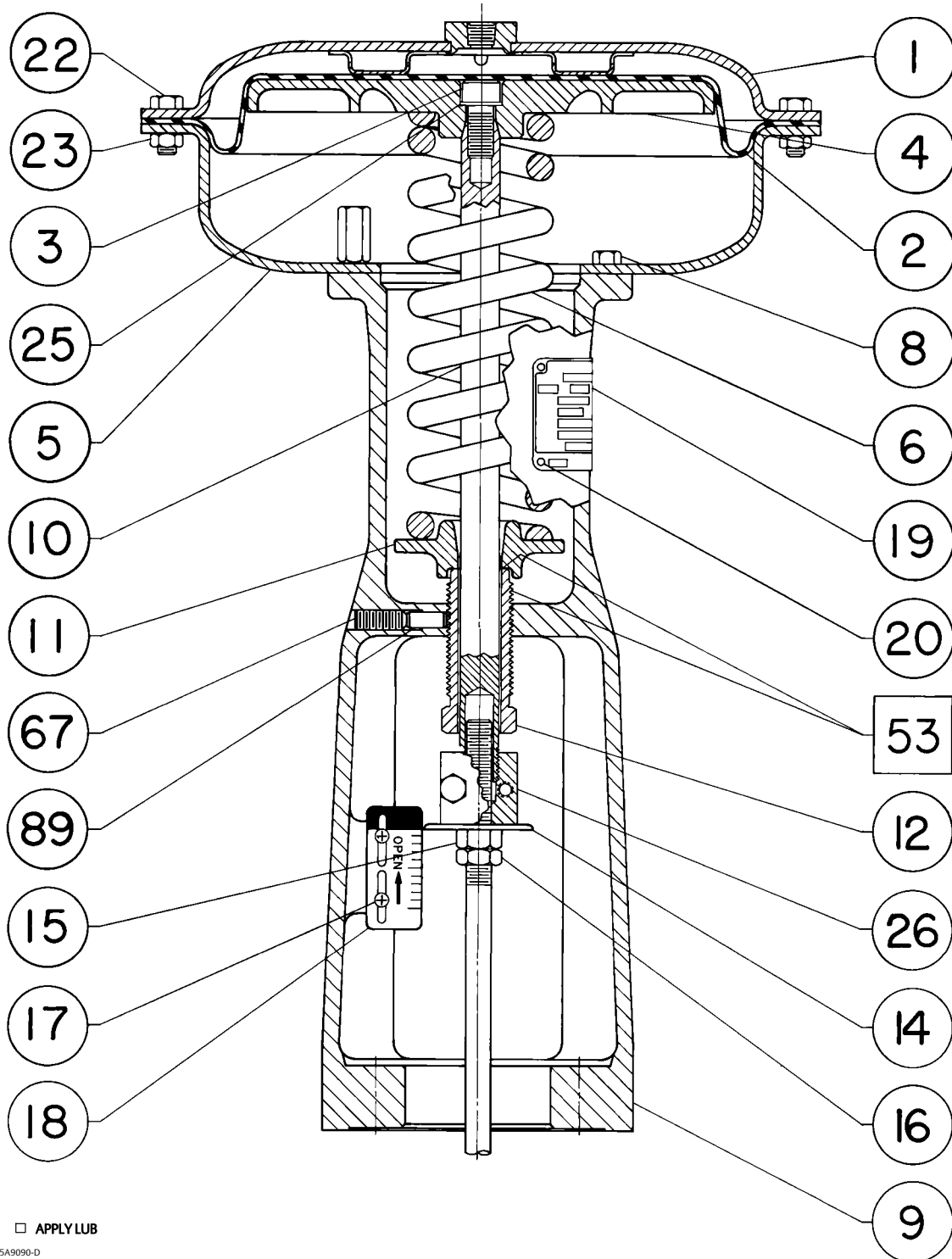
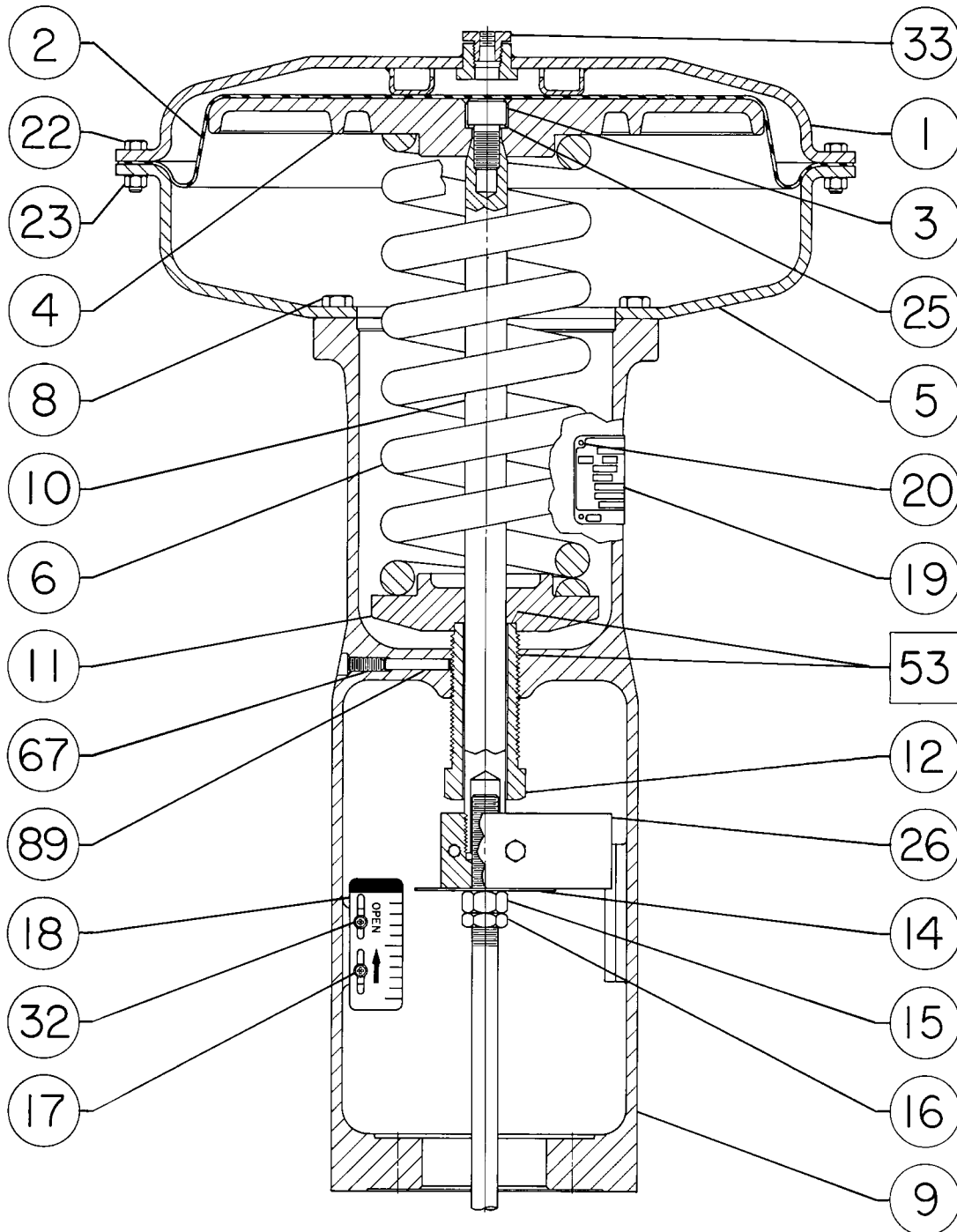
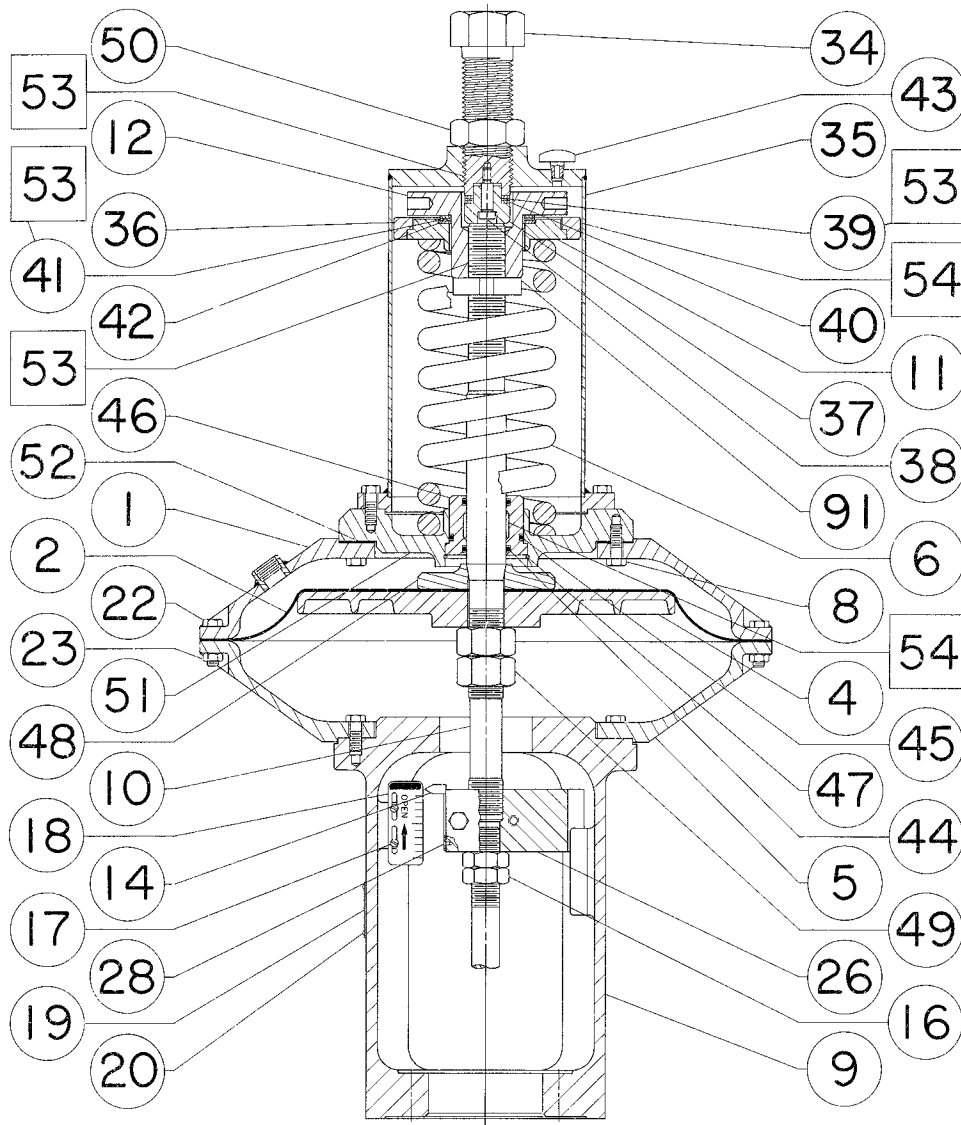


Figure 3. Size 70 Fisher 657NS Actuator



□ APPLY LUB
55A9192-C

Figure 4. Size 80 Fisher 657NS Actuator



□ APPLY LUB

56A1030-C

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