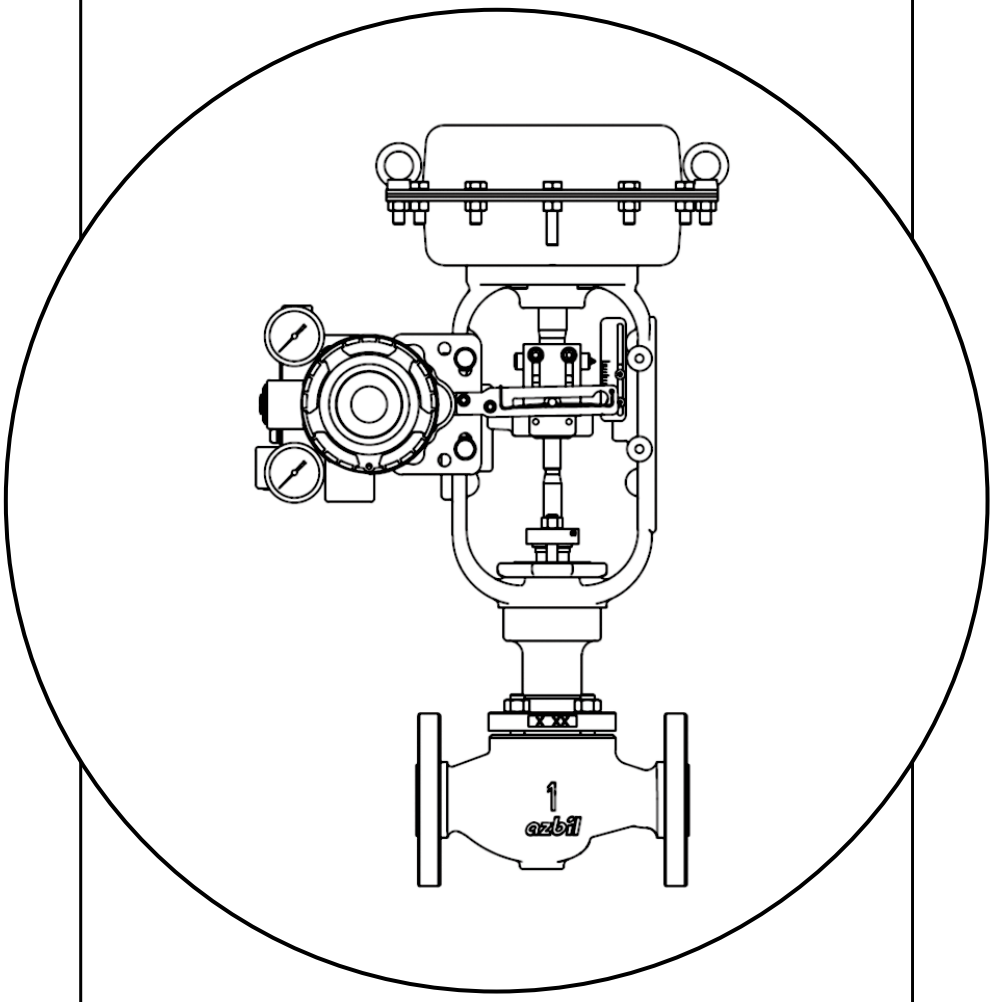
azbil

CM2-CVP100-2001

Globe Control Valve

Model AS111/AS211/AS311/
AC111/AC211/AC311

User's Manual



Azbil Corporation

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Please make sure that this manual is available to the user of the product.

Unauthorized duplication of this user's manual in part or in whole is forbidden. The information and specifications in this manual are subject to change without notice.

Considerable effort has been made to ensure that this manual is complete and accurate, but if you should find an omission or error, please contact us.

In no event is Azbil Corporation liable to anyone for any indirect, special, or consequential damages as a result of using this product.

Be sure to read this manual before using the product.

Conventions Used in This Manual

The safety precautions explained below aim to prevent injury to you and others, and to prevent property damage.

⚠**WARNING**	Warnings are indicated when mishandling the product might result in the death or serious injury of the user.
⚠**CAUTION**	Cautions are indicated when mishandling this product could result in minor injury.

In describing the product, this manual uses the icons and conventions listed below.

⚠	Indicates that caution is required in handling.
⃠	The indicated action is prohibited.
❗	The indicated instructions must be observed.

Important	If the instructions are not observed, this device may fail or be damaged.
Handling Precautions	Information to be aware of when handling.
(1) (2) (3)	Steps in a sequence or parts of a figure, etc.

Precautions for Safe Operation

⚠ WARNING

Before starting to work, check that the pressure in the pipes has dropped to atmospheric pressure. If fluid spews out, injury may result.

⚠ CAUTION

Do not stand on the device or use it as a step. There is a risk of falling.
Do not touch the device unnecessarily while it is operating. Depending on the operating conditions, the surface might be extremely hot or cold.
Since this product is heavy, when handling it, wear safety shoes and watch your step.
During work, wear protective goggles to prevent injury from flying objects and harm from chemicals.
During work, wear protective gloves to prevent injury from burrs on bolt heads or edges and harm from chemicals.
While this device is operating, do not touch movable parts such as the stem connector. Your hand, etc., may be caught in the mechanism and be injured.
When assembling or disassembling the diaphragm, which is part of the actuator, wear protective gloves to prevent prolonged contact with your skin. “Prolonged contact” refers to total daily skin contact of 10 minutes continuously or 30 minutes intermittently.

Handling Precautions

■ Installation precautions

⚠ WARNING

When connecting the valve to the piping, do not put your hand or foot under the body or between flanges. You may lose your fingers or your foot may be injured.
Before reinstalling the valve after maintenance or modification, wash out any residual fluid in the pipes or replace it with a safe fluid. Otherwise, the residual fluid may cause an injury.
Check that there is no damage to the flanges or welded piping. If fluid leaks, it may cause injury.
Check that the pipes on both sides of the valve are firmly supported. Insufficient support may cause leakage from pipe connections, potentially causing injury.
After installation, check that the pipes are still properly aligned. Misalignment may cause fluid leakage from pipe connections, potentially causing injury.
Use bolts and nuts that conform to the standards for the pipe flange. If fluid leaks, it may cause injury.
Use new flange gaskets that are appropriate for the properties of the fluid, the operating temperature, and the pressure. Damaged gaskets may cause fluid leakage, potentially causing injury.
When keeping the valve warm or cold, also keep the stud bolts and nuts that connect the body and the bonnet warm or cold. Thermal deformation may cause fluid leakage, potentially causing injury.
Tighten the bolts and nuts for the flanges evenly in a diagonal pattern. If fluid leaks, it may cause injury.

⚠ CAUTION

If the valve is installed along a passageway used by outsiders, install a fence or cover as a protective measure.
If pipe flanges connected to the valve are being welded, the body surface may also heat up. Do not touch the valve unnecessarily.
Chamfer the edges of the pipe flanges. Sharp edges can cause an injury.

Important

- **If the centers of the control valve flange and the pipe flange are misaligned, the pipe mounting nuts may interfere with the side of the valve body. When installing, visually check or use a metal ruler to ensure that the centers of the flanges are properly aligned.**
- **The protrusion of the pipe mounting bolts beyond the nuts should be limited to 2 to 3 threads. Excessive protrusion may cause interference with the side of the valve body. If the protrusion is too large, use flat washers or similar components on the piping side to adjust the protrusion.**

■ Precautions for air supply piping and electrical work

⚠ WARNING

Wiring should be carried out only by qualified technicians and should comply with local electrotechnical standards. Otherwise, there is a danger of electric shock.

■ Precautions for assembly and disassembly

⚠ WARNING

Do not disassemble the pneumatic actuator while supply air pressure is being applied. The compressed air may cause an injury.
Before starting work, clean the inside of the valve, replace any residual gas, etc. Otherwise, the residual fluid may cause an injury.
Because damaged or corroded bolts and nuts may damage the valve and cause injury, replace them with new ones.
For an actuator that incorporates compressed coil springs, follow the disassembly procedure when removing bolts, nuts, etc. Otherwise, the springs may jump out, causing an injury.
When reassembling the valve body, always use new packing and gaskets. The reuse of old parts may cause fluid leakage, potentially causing injury.

■ Precautions for maintenance

⚠ WARNING

If fluid leakage from the valve is found, stay away from the valve until safety can be confirmed. Depending on the properties of the fluid, a serious accident or injury may result.
When assembling the valve, check that the packing (gaskets) is in place and tighten the screws evenly.

Introduction

Thank you for purchasing Azbil's model AS111/AS211/AS311/AC111/AC211/AC311 control valve. With the improved leakage performance of this device, instrumentation costs can be reduced significantly. Azbil is proud to provide high reliability and quality based on its abundant achievements and know-how in the field.
This user's manual describes how to use this device safely and reliably. Be sure to read this manual before using the product. After reading the manual, be sure to keep it in a place where users can refer to it at any time.

■ Unpacking and storing the product

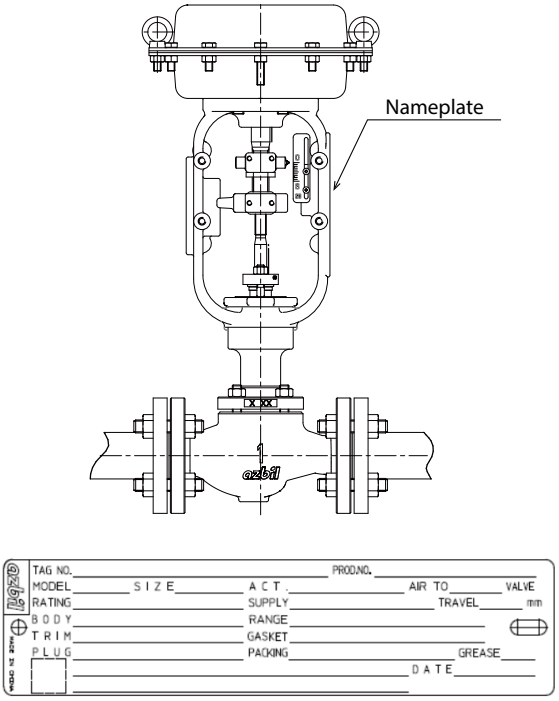
● Unpacking

This device is a precision instrument. Take special care in handling the valve to prevent accidents, damage, etc.
When unpacking, check for the following items.

- The valve, actuator, and parts to be mounted
- Any auxiliary devices that you ordered

● Checking the specifications

Check that the fluid conditions, valve number (tag No.), and the specifications printed on the name plate are correct and appropriate. The location of the product's nameplate is shown in the figure below.



Position of the nameplate

● Inquiries

For inquiries about this device, contact the azbil Group.
When making an inquiry, have your model number and product number ready.

● Precautions for storage

Observe the following precautions in order to store the purchased valve properly.

- If the valve is packed in a cardboard box, store it indoors at room temperature and humidity.
- A valve packed in a wooden crate should also generally be stored indoors at room temperature and humidity. For outdoor storage, after unpacking the valve and checking the specifications, cover it with a polyethylene protective sheet to keep rainwater out.

To store a valve that has been used, follow the instructions below.

1. Wash out any fluid stuck to or remaining in the interior of the valve.
2. If it is likely that the valve will corrode, take preventive measures.
3. Cover the openings for air supply and electrical conduit connections with waterproof caps or tape to keep water out.
   In addition, protect the threads on the connectors.
4. Protect the ends of piping connections (flanges, welded surfaces) using flange caps or the like.
5. Store the product in a location that is subject to minimal vibration and shock.

Table of Contents

Chapter 1 Structure of the Control System

1-1 Introduction

This control valve operates by receiving 4–20 mA DC or 20–100 kPa signals and is driven by 140–400 kPa clean supply air.

Figure 1-1 illustrates a typical control valve system.

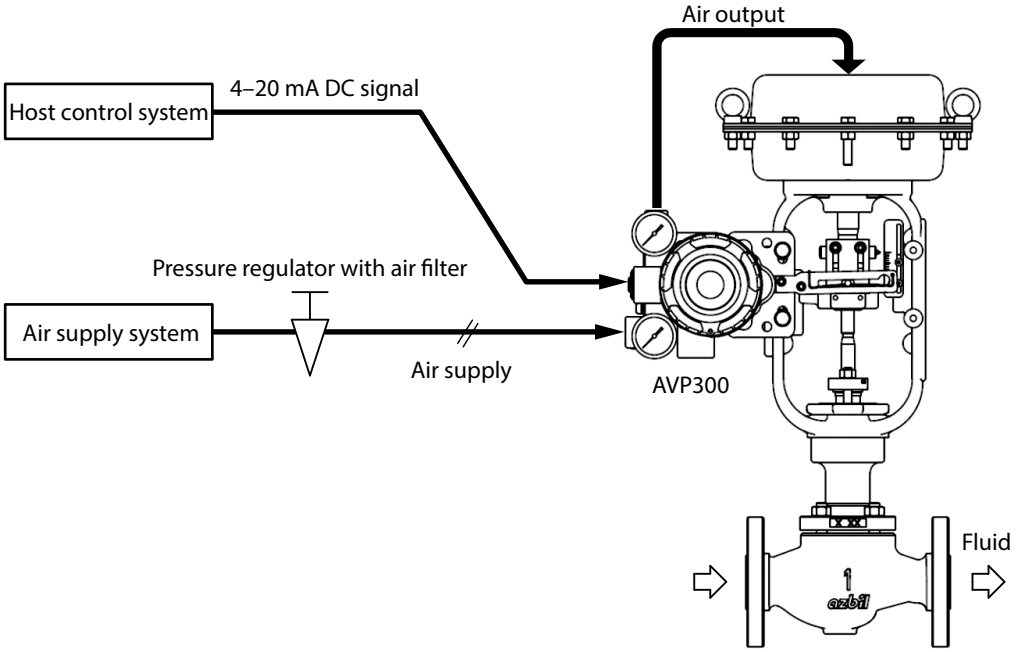


Figure 1-1. Control System

This manual contains operating instructions for our control valves. For details on positioners, refer to the user's manuals below.

Smart valve positioner 300 series (model AVP300/301/302 (integral type)

document No. CM2-AVP300-2001

Smart Valve Positioner 300/200 HART + Travel Transmission (model AVP307 (integral type) / AVP207 (remote type))

document No. CM2-AVP307-2001

1-2 Control Valve Structure

This device is composed of a valve body and an actuator. The valve body consists of a body, bonnet, plug, and other components. The actuator consists of a diaphragm, compressed coil springs, and other components. Figure 1-2 illustrates the structure of this device.

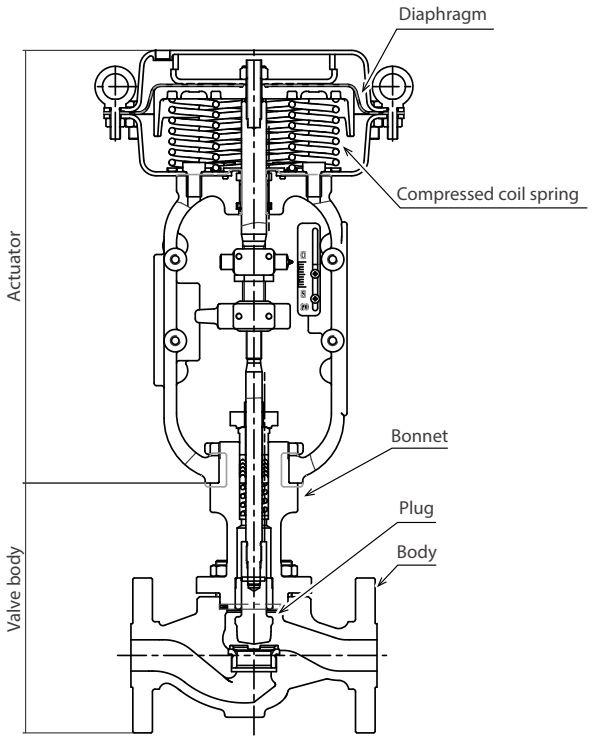


Figure 1-2. Structure

Names and functions of the components are described below.

Name	Function
Valve body	• Controls fluid flow. • Connects to a pipe and contains all valve components.
Plug	• Regulates flow rate, pressure, etc., by changing the size of the flow area.
Body	• The part through which the fluid flows. Connects to a pipe. • The main component of the pressure vessel
Bonnet	• Regulates the valve plug performance in accordance with a change in flow. • A component of the pressure vessel
Actuator	• Adjusts valve travel in accordance with the signal received.
Diaphragm	• Converts air pressure.
Compressed coil spring	• Adjusts valve plug position.

For details on the structure of the valve body, refer to Figure 5-2 to Figure 5-6.
For details on the structure of the actuator, refer to Figure 6-1 to Figure 6-5.

1-3 Specifications of the Control Valve

Since the control valve contacts the process fluid, its specifications must be appropriate for the process conditions and the purpose of use. The standard specifications are described in Appendix A: Standard Specifications.

⚠ CAUTION

Do not use the control valve for applications other than those for which it was designed. The specifications of the control valve, such as the rated pressure and material of the valve body and trim material, are determined by the fluid conditions. Failure to comply with this caution may result in burns or injuries due to high temperature or leakage of hazardous fluid.

This control valve must be used in compliance with all applicable safety regulations, specifications, and standards.

1-4 External Dimensions and Weight

The external dimensions and weight are given in Appendix B: Dimensions and Weight. Please refer to it during installation, etc.

Chapter 2 Installation

2-1 Installation Location

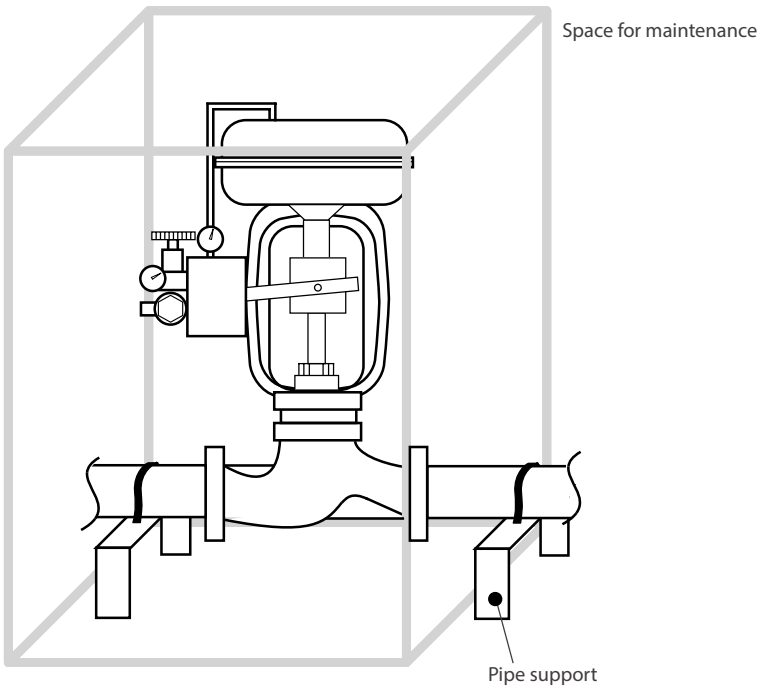
Please observe the following cautions when selecting the installation site for the control valve.

⚠ WARNING
When connecting the valve to the piping, do not put your hand or foot under the body or between flanges. You may lose your fingers or your foot may be injured.
Before reinstalling the valve after maintenance or modification, wash out any residual fluid in the pipes or replace it with a safe fluid. Otherwise, the residual fluid may cause an injury.
Check that there is no damage to the flanges or welded piping. If fluid leaks, it may cause injury
Check that the pipes on both sides of the valve are firmly supported. Insufficient support may cause leakage from pipe connections, potentially causing injury.
After installation, check that the pipes are still properly aligned. Misalignment may cause fluid leakage from pipe connections, potentially causing injury.
Use bolts and nuts that conform to the standards for the pipe flange. If fluid leaks, it may cause injury.
Use new flange gaskets that are appropriate for the properties of the fluid, the operating temperature, and the pressure. Damaged gaskets may cause fluid leakage, potentially causing injury.
When keeping the valve warm or cold, also keep the stud bolts and nuts that connect the body and the bonnet warm or cold. Thermal deformation may cause fluid leakage, potentially causing injury.
Tighten the bolts and nuts for the flanges evenly in a diagonal pattern. If fluid leaks, it may cause injury.

⚠ CAUTION
If the valve is installed along a passageway used by outsiders, install a fence or cover as a protective measure.
If pipe flanges connected to the valve are being welded, the body surface may also heat up. Do not touch the valve unnecessarily.
Chamfer the edges of the pipe flanges. Sharp edges can cause an injury.

Important

- **If the rated pressure or standards for connection are ignored when this device is used, damage to the product or leakage may cause a serious accident.**
- **Make sure that there is a straight pipe section at least 10 times the pipe diameter on the upstream side and 6 times the pipe diameter on the downstream side (D: nominal diameter). If the straight pipe sections are not long enough, insufficient valve capacity or unusual noise or vibration could result.**
- **Install the valve in the correct direction, leaving clearance around the valve as much as possible for easy maintenance (piping, wiring, adjustment, etc.).**
- **Provide appropriate support for the valve itself and for connected pipes to prevent an excessive load from the weight and operation of the valve. (Care is needed especially for large valves and valves for low-temperature fluid.)**
- **Do not install the valve where it may be submerged by rainwater, covered with snow, or subject to freezing. Otherwise the valve might be damaged.**
- **If the valve is exposed to radiant heat, provide a shielding plate or the like. Failure to do so may result in damage to the actuator or auxiliary equipment.**
- **If the valve is exposed to salt or a corrosive atmosphere, take measures against corrosion. Otherwise the valve might be damaged.**
- **Check that there is no damage to the valve (including the actuator and auxiliary equipment).**
- **If the eyebolts (eyenuts) attached to the actuator are used to lift the valve, make sure that the weight does not exceed the limit specified in the user's manual. An excessive load may damage the actuator or cause air leakage.**
- **Do not hang the product using a sling or other means in locations other than those specified in this user's manual. Threads of long bolts, etc., may become deformed, making disassembly impossible or damaging the product.**
- **Open the valve fully before flushing the inside of the piping, and do not change the valve travel while the pipes are being flushed. Otherwise, the valve may be damaged by welding spatter or other foreign matter.**
- **Do not hang the product using a sling or other means in locations other than those specified in this user's manual. Threads of long bolts, etc., may become deformed, making disassembly impossible or damaging the product.**
- **Open the valve fully before flushing the inside of the piping, and do not change the valve travel while the pipes are being flushed. Otherwise, the valve may be damaged by welding spatter or other foreign matter.**
- **Avoid installing the valve where it will be subject to vibration or other external forces that may affect its performance.**
- **Protective covers are attached to the flanges to protect the gasket-contacting surfaces and to prevent foreign matter from entering the valve. When installing the valve, remove the covers.**
- **To prevent seat damage and impaired closing performance, remove foreign matter such as dust, sand, and welding spatter from the inside of the piping, and clean the inside of the valve.**
- **Check that the distance between the pipe flanges is equal to the total of the face-to-face length of the valve and the thickness of the gaskets.**
- **If the centers of the control valve flange and the pipe flange are misaligned, the pipe mounting nuts may interfere with the side of the valve body. When installing, visually check or use a metal ruler to ensure that the centers of the flanges are properly aligned.**
- **The protrusion of the pipe mounting bolts beyond the nuts should be limited to 2 to 3 threads. Excessive protrusion may cause interference with the side of the valve body. If the protrusion is too large, use flat washers or similar components on the piping side to adjust the protrusion.**



The control valve is designed to withstand severe operating conditions. However, in order to achieve its optimal performance, install the valve to a location with the following conditions:

Ambient temperature: –30 to +70 °C

Relative humidity: 10 to 90 %

Vibration: 2 G max. (5 to 400 Hz)

Handling Precautions

- The vibration specification is for the AVP positioner mounted on the PA actuator.

Important

- **If the pressure regulator with air filter is mounted on this device, install this device on the piping so that the drain of the regulator faces downward. If the regulator cannot be vertical (if its drain does not face downward), remove it from this device.**
- **Rainwater may enter the pressure gauge, so install this device so that the gauge does not face upward or downward. Also, there is a rainwater drain hole at the bottom of the pressure gauge. The hole must be positioned facing downward.**

2-2 Inspection before Installation

Check the following before installing the control valve on the piping.

(1) The specifications printed on the name plate are appropriate for the use.

(2) There is no damage to the control valve (valve body, actuator, auxiliary equipment, etc.).

(3) There is no damage to the flanges.

(4) Eyebolts for hoisting are attached to the actuator. If the eyebolts are used to hoist the control valve, make sure that the weight including accessories does not exceed the limit specified in Table 2-1 and Table 2-2.

(5) If the eyebolts are used to hoist the control valve, the degree between the actuator and the wire rope must be 60° or more. (Refer to Figure 2-1).
If the maximum weight for hoisting with eyebolts is exceeded, pass slings, or the like, alternately through the upper part of the yoke. (Refer to Figure 2-2).

(6) The piping can support the weight of the control valve (refer to Table 2-1 and Table 2-2).

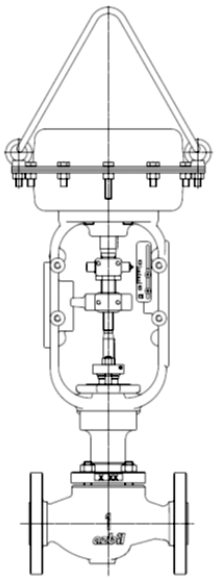


Figure 2-1.

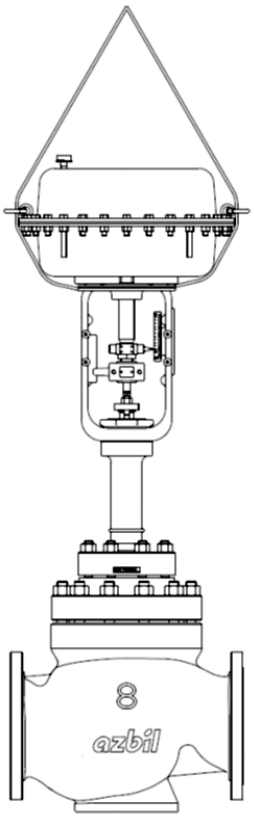


Figure 2-2.

Table 2-1. Maximum weight for hoisting with eyebolts (without side handwheel)

Weight tolerance: +20/0 %

Nominal diameter (inches)	Actuator	Weight (kg)						Max. weight for hoisting with eyebolts (kg)
		class150		class300		class600		
		Plain bonnet	Extension bonnet	Plain bonnet	Extension bonnet	Plain bonnet	Extension bonnet	
		Normal temp. (–17 to +230 °C)	High temp. (230 to 400 °C) /low temp. (–45 to –17 °C)	Normal temp. (–17 to +230 °C)	High temp. (230 to 400 °C) /low temp. (–45 to –17 °C)	Normal temp. (–17 to +230 °C)	High temp. (230 to 400 °C) /low temp. (–45 to –17 °C)	
½	PA2	17	18	18	19	19	20	80
	PA3	27	28	28	29	29	30	80
¾	PA2	18	18	19	20	20	20	80
	PA3	28	28	29	30	30	30	80
1	PA2	18	19	20	20	21	21	80
	PA3	28	29	30	30	31	31	80
1½	PA2	30	32	33	35	42	44	80
	PA3	40	42	43	45	52	54	80
	PA4	69	71	72	74	81	83	150
	PA5	103	105	106	108	115	117	220
2	PA2	33	35	36	37	38	40	80
	PA3	43	45	46	47	48	50	80
	PA4	72	74	75	77	77	79	150
	PA5	106	108	109	111	111	113	220
2½	PA3	63	66	64	66	70	72	80
	PA4	94	98	94	97	100	104	150
	PA5	128	132	128	131	134	138	220
3	PA3	66	69	70	72	77	80	80
	PA4	98	101	100	102	108	111	150
	PA5	132	135	134	136	142	145	220
4	PA3	91	93	98	100	116	119	80
	PA4	124	126	129	132	148	152	150
	PA5	158	160	163	166	182	186	220
6	PA5	232	235	255	258	320	323	220
8	PA5	332	335	371	375	445	449	220

Table 2-2. Maximum weight for hoisting with eyebolts (with side handwheel)

Weight tolerance: +20/0 %

Nominal diameter (inches)	Actuator	Weight (kg)						Max. weight for hoisting with eyebolts (kg)
		class150		class300		class600		
		Plain bonnet	Extension bonnet	Plain bonnet	Extension bonnet	Plain bonnet	Extension bonnet	
		Normal temp. (–17 to +230 °C)	High temp. (230 to 400 °C) /low temp. (–45 to –17 °C)	Normal temp. (–17 to +230 °C)	High temp. (230 to 400 °C) /low temp. (–45 to –17 °C)	Normal temp. (–17 to +230 °C)	High temp. (230 to 400 °C) /low temp. (–45 to –17 °C)	
½	PA2	27	28	28	29	29	30	80
	PA3	37	38	38	39	39	40	80
¾	PA2	28	28	29	30	30	30	80
	PA3	38	38	39	40	40	40	80
1	PA2	28	29	30	30	31	31	80
	PA3	38	39	40	40	41	41	80
1½	PA2	40	42	43	45	52	54	80
	PA3	50	52	53	55	62	64	80
	PA4	113	115	116	118	125	127	150
	PA5	147	149	150	152	159	161	220
2	PA2	43	45	46	47	48	50	80
	PA3	53	55	56	57	58	60	80
	PA4	116	118	119	121	121	123	150
	PA5	150	152	153	155	155	157	220
2½	PA3	73	76	74	76	80	82	80
	PA4	138	142	138	141	144	148	150
	PA5	172	176	172	175	178	182	220
3	PA3	76	79	80	82	87	90	80
	PA4	142	145	144	146	152	155	150
	PA5	176	179	178	180	186	189	220
4	PA3	101	103	108	110	126	129	80
	PA4	168	170	173	176	192	196	150
	PA5	202	204	207	210	226	230	220
6	PA5	276	279	299	302	364	367	220
8	PA5	376	379	415	419	489	493	220

2-3 Installation on the Pipe

■ Standard installation example

Figure 2-3 illustrates standard installation.

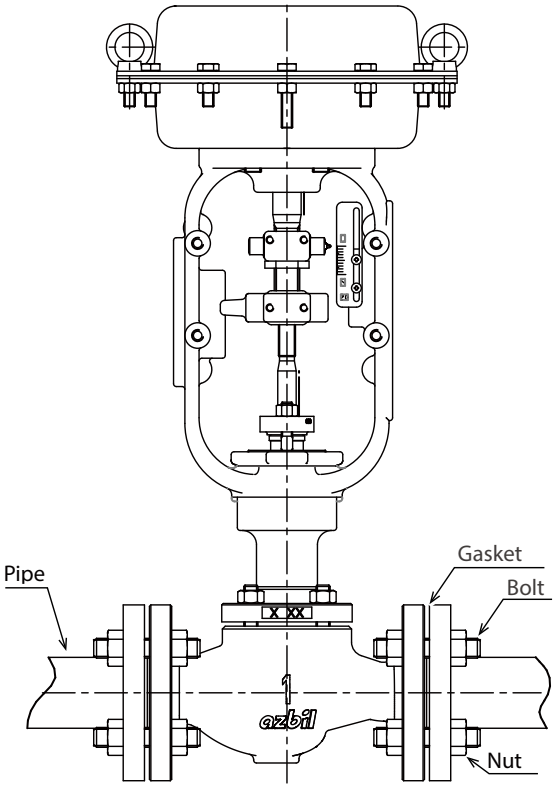
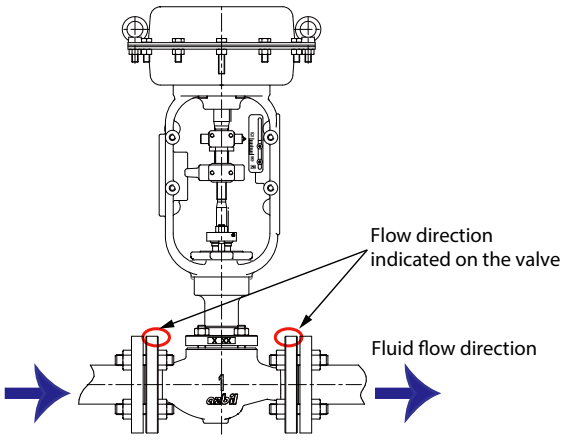
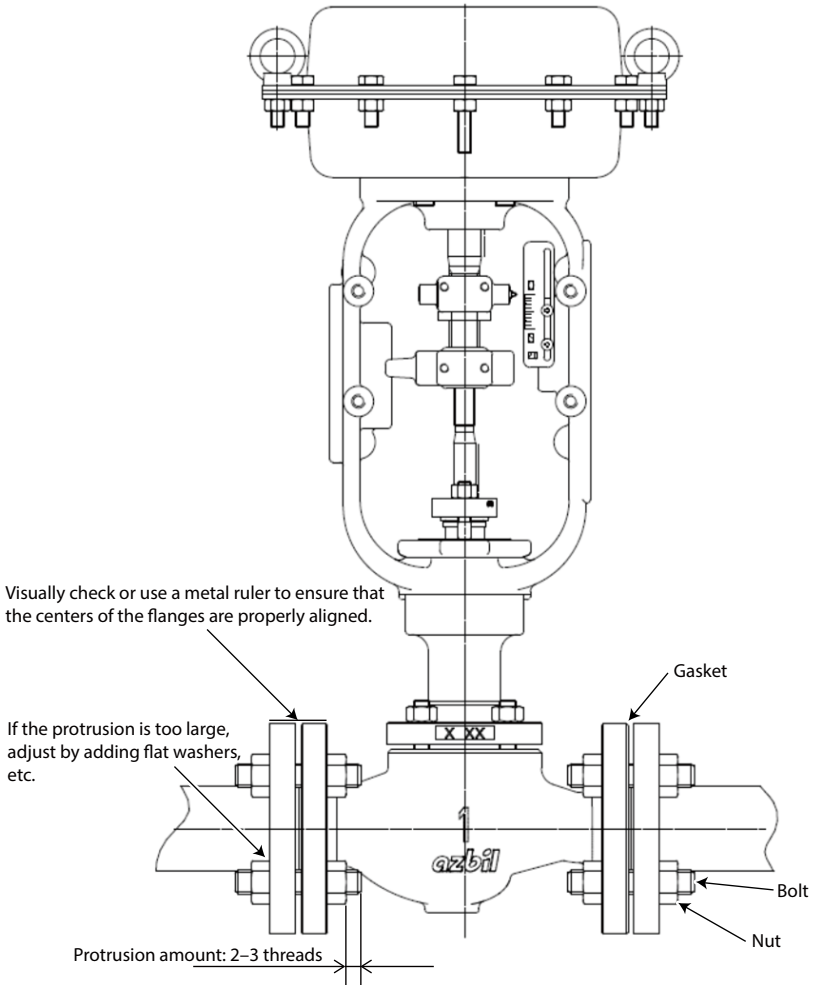


Figure 2-3. Installation on the pipe

■ Installation method

Step	Procedure
1	Check that the flow direction of the process fluid is the same as the direction indicated on the control valve.  Figure 2-4. Flow direction indicated on the valve
2	Attach the valve and gaskets to the pipes. Loosely tighten the nuts of the flange bolts.

Step	Procedure
3	Make sure that the gaskets do not protrude into the flow path and constrict the inner diameter of the body.
4	If the centers of the control valve flange and the pipe flange are misaligned, the pipe mounting nuts may interfere with the side of the valve body. When installing, visually check or use a metal ruler to ensure that the centers of the flanges are properly aligned. The protrusion of the pipe mounting bolts beyond the nuts should be limited to 2 to 3 threads. Excessive protrusion may cause interference with the side of the valve body. If the protrusion is too large, use flat washers or similar components on the piping side to adjust the protrusion. Tighten the bolts and nuts for the flanges evenly and securely in a diagonal pattern.  Figure 2-5.
5	After installation is complete, check that all bolts and nuts are securely tightened and there is no leak from the piping.

2-4 Air Supply Connection

See the user's manual for your positioner.

- Smart valve positioner 300 series (model AVP300/301/302 (integral type))
  document No. CM2-AVP300-2001

- Smart valve positioner 300 series HART + travel transmission (model AVP307 (integral type))
  document No. CM2-AVP307-2001

2-5 Inspection after Installation and Precautions for Operation

! Handling Precautions

- Check the air pipe connections for leakage before use.
- Make sure that the bolts and nuts of the diaphragm case, bonnet, etc., are firmly tightened.
- The temperature inside and outside the valve should be increased or decreased gradually (100 °C/h or less). Avoid operating the valve while the valve temperature is increasing or decreasing.
- When using the valve at low temperatures, gradually lower the temperature (50 °C/h or less)
- After applying pressure to the valve, check for leakage from the valve body, gland packing, and gaskets, Use the torque indicated in Figure 5-1 and Figure 5-2.
- For a valve with a lubricator, check whether the bonnet section has been lubricated or not.
  To do this, loosen the lubricator handle and turn the squeeze screw. If the squeeze screw turns lightly, replenish grease using the following procedure.
- Note that too much grease may cause hunting.

■ Grease replenishing procedure

(1) Obtain grease of the type indicated on the nameplate.

(2) Tightly close the lubricator handle.

(3) Remove the squeeze screw, apply grease, and set the squeeze screw.

(4) Loosen the lubricator handle and squeeze in the grease by turning the squeeze screw.

(5) Repeat steps 2 to 4 until it becomes difficult to turn the squeeze screw. Tightly close the lubricator handle.

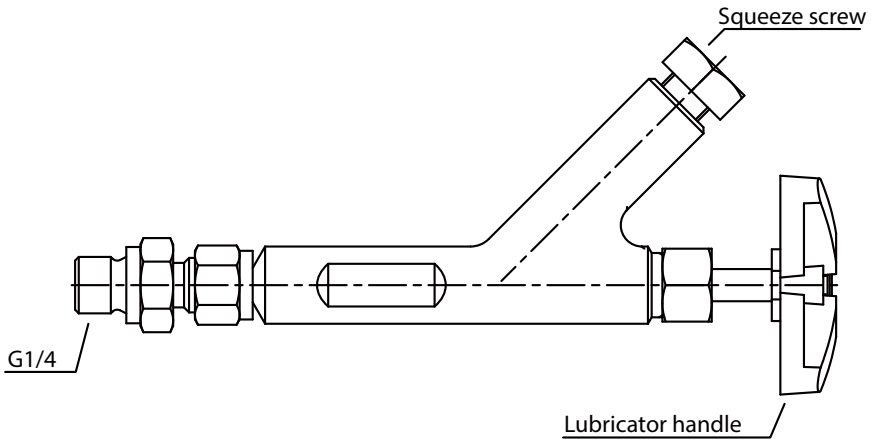


Figure 2-6.

Chapter 3 Operation

3-1 Trial-Run Inspection and Adjustment

■ Operation test

Send a 4–20 mA DC or other dummy signal (0 to 100 %) to the valve positioner or actuator to check that the rated travel is achieved.

Refer to Table 3-1 and if the allowable value is exceeded, adjust the valve positioner. For adjustment of the valve positioner, refer to the related user's manual indicated in "Chapter 1 Structure of the Control System".

Table 3-1. Control valve performance (when shipped from factory)

Positioner	Hysteresis	Linearity
AVP	Within 1 % FS	Within ±1 % FS

■ Loop check

Send signals from the host control system, and check that signal wires are connected as specified and that the functional requirements for control are satisfied.

3-2 Use of the Side Handwheel

This section describes opening and closing the control valve with the side handwheel.
If you need to use the side handwheel, refer to this section. Figure 6-17 illustrates the side handwheel structure.

■ Precautions

If the handwheel is used when the equipment is running, make sure that manual opening/closing of the control valve does not affect the operation of the equipment.

■ Procedure

Important

- **Do not apply excessive force when the mechanical stop position of the control valve has been reached. Otherwise you may damage the valve stem. If the valve stops at an abnormal position, refer to 3-3, "Troubleshooting" and take the necessary countermeasures.**

Step	Procedure
1	Disengage the locking chain that holds the handwheel.
2	Check the OPEN and SHUT arrows cast on the handwheel, and rotate the handwheel in the desired direction to open or close the valve. The maximum turning torque: PA2: 245 N PA3: 340 N PA4: 382 N PA5: 555 N
3	When the handwheel does not turn any further, stop trying to turn it and check the amount of valve travel.
4	To resume automatic operation, turn the handwheel until the pointer on the lever drive nut reaches the AUTO range. Lock the handwheel with the locking chain, and resume automatic operation.

3-3 Troubleshooting

Problems that might occur during operation are described in Table 3-2.
Take necessary measures such as replacing parts, depending on the circumstances.

Table 3-2. Control valve problem causes and countermeasures

Phenomenon		Cause	Countermeasure
Unreliable valve operation	The valve hunts near the fully closed position.	The valve capacity is too large.	Reduce the differential pressure between the inlet and outlet of the valve. Replace the valve trim with trim that has a smaller Cv.
		Reverse flow direction	Check that the flow direction indicated on the valve is the same as the fluid direction. If not, change the direction.
	Fluctuation in supply air pressure	Insufficient instrumentation air capacity of the equipment	Increase the capacity of the compressor. Install an additional dedicated compressor.
		Failure of the air pressure regulator	Check the air pressure regulator.
	Hunting of signal pressure	The resistance or air volume of the control loop is not suitable.	Insert an air volume tank or restrictor into the signal pressure line.
		Failure of the controller	Check the controller.
	The valve hunts even though signals and supply air pressure are stable.	Hunting of the positioner circuit	Check for wear of the positioner Check the positioner and pilot valve Reduce the sensitivity of the positioner
		Fluctuation in axial thrust due to changes in fluid pressure in pipes	Reduce the differential pressure between the inlet and outlet of the valve. Replace the actuator with one that has more rigidity. Add a positioner.
Valve vibration	The valve vibrates at any travel.	Insufficient support for the piping	Support the inlet and outlet of the valve.
		There is a source of vibration around the valve.	Remove the source of vibration.
		The guide is worn out.	Replace the guide bushing and/or the plug.
Slow valve stroke	Valve stroke is slow in both opening and closing directions.	The plug guide, the fluid retaining part of the bonnet, etc., is clogged with slurry.	Disassemble and clean. Install a steam jacket on the valve body.
		The gland packing is hardened.	Replace the gland packing or the grease.

Table 3-2. Control valve problem causes and countermeasures

Phenomenon		Cause	Countermeasure
Valve not operating	Supply air pressure is normal, but signal pressure does not increase	Leakage from the signal pipe	Check the signal pipe (especially the fitting)
		Leakage from the diaphragm or damage to the diaphragm	Replace the diaphragm.
		Leakage from the signal receiver of the positioner or damage to it	Replace the bellows receiver and/or the diaphragm
		Failure of the controller	Check the controller.
	Signal pressure is normal, but supply air pressure drops or air is not supplied	Clogging of the filter in the air pressure regulator	Clean the filter.
		Leakage or clogging of the air pipe	Check the air pipe (especially the fitting)
		Failure of the air pressure regulator	Check the air pressure regulator.
	No positioner output	Failure of the positioner and pilot valve	Check the positioner and pilot valve.
		Leakage from the actuator diaphragm or damage to the diaphragm	Replace the diaphragm.
	The valve does not operate even though air is supplied to the actuator	The stem, valve plug guide, etc., is stuck due to heat or foreign matter.	Replace the parts.
		Foreign matter is caught in the valve plug.	Disassemble, inspect, and clean the valve body.
		The stem is bent.	Replace the stem.
		Actuator failure	Check the operation of the actuator.
Valve does not fully open / leakage from the valve interior in large amounts	The stem is at the valve fully-open position.	The plug and/or the seat ring is corroded, eroded, abraded, or otherwise damaged.	Replace the plug or/and the seat ring (consider using hardened parts)
		Parts on the outer circumference of the seat ring (thread or gasket) are corroded or eroded.	Replace the seat ring or the gasket. Use a different mounting method for the seat ring (e.g., welding).
		The fluid leaks from the partition of the body.	Replace the body.
	The stem does not reach the fully closed position.	The differential pressure of the fluid is too great.	Reduce the differential pressure. Increase the output from the actuator.
		Foreign matter is caught in	Disassemble, inspect, and clean the valve body.
		The guide, plug, etc., is stuck due to heat	Replace the guide, plug, etc.

Table 3-2. Control valve problem causes and countermeasures

Phenomenon		Cause	Countermeasure
	Fluid leaks from the gland packing.	Looseness of the gland packing or bolts	Tighten the gland packing or bolts.
		Grease depleted (for graphite yarn packing)	Replenish the grease.
		The gland packing has deteriorated.	Replace the gland packing (consider using a packing of a different material)
		The stem, interior of the packing box, etc., is damaged, corroded, or eroded.	Disassemble and re-machine or replace parts. Attach a felt ring or rubber bellows to protect the stem (if there is a lot of foreign matter).
	Fluid leaks from the gasket.	The gasket is damaged, corroded, or eroded.	Replace the gasket (consider using a gasket of a different material)
	The amount of valve travel or the control rangeability have narrowed	The valve characteristic has changed because the plug is corroded, eroded, or abraded.	Replace the plug, seat ring, etc. (consider using parts of a different material for better corrosion-resistance and rigidity)

Chapter 4 Maintenance

4-1 Inspection of the Control Valve

Check the control valve in accordance with the following instructions in order to maintain proper performance, prevent accidents, and detect problems early. Daily inspection and periodic inspection (overhaul) must be carried out. When inspecting the valve, be sure to observe the instructions below.

⚠ WARNING

If fluid leakage from the valve is found, stay away from the valve until safety can be confirmed. Depending on the properties of the fluid, a serious accident or injury may result.

■ Daily inspection

The following items should be checked in daily inspections of the equipment.

● Items to check

● Gland

Check for a fluid leak from the gland. If a leak is found, take necessary measures, referring to "3-3 Troubleshooting".

● Flange connections

Check the flange between the body and the bonnet, and the flange between the body and the piping, for fluid leakage. If a leak is found, take necessary measures, referring to "3-3 Troubleshooting".

● Control valve operation

Check for any abnormal operation such as hunting. If the valve is hunting, take necessary measures, referring to "3-3 Troubleshooting".

● Abnormal noise or sound

Check that there is no abnormal sound or vibration from the device during operation. If any problem is found, take necessary measures, referring to "3-3 Troubleshooting".

[!] Handling Precautions

- Check the gland daily for leakage.
- Check valve operation daily for hunting.
- Check that there is no abnormal sound or vibration from the device during operation.

■ Periodic inspection

Disassemble the control valve once every two or three years. Replace consumables and repair or replace any parts that have deteriorated. When disassembling the valve, be sure to observe the instructions in chapter 5, “Disassembly and Reassembly of the Control Valve.”

● Recording inspection results

Recording the results of periodic inspection on the following items is recommended. The records will be useful in estimating the remaining service life of the product, troubleshooting, identifying consumables that should be replaced, and in other various circumstances.

● Precautions

- Before uninstalling the control valve from the equipment, check that removal of the valve will not affect the performance of the equipment.
- When disassembling the control valve, refer to 5-2, “Disassembling the Valve Body” for the particular model and take necessary notes for reassembly of the valve.
- Before disassembling the control valve, send dummy inputs to the actuator or the positioner to check for any problems.

● Items to check

● Appearance

Check the diaphragm case, rain cap, yoke, stem connector, bonnet, body, bolts, nuts, and air piping for damage or corrosion, and check that all necessary parts are attached. In addition, check if the paint is worn out.

● Damage to stems

Check the valve stem and actuator rod for damage.

● Leakage from the body and bonnet connection

Check the connection between the body and bonnet for any signs of leakage.

● Leakage from the gland

Check the gland for any signs of leakage.

● Damage to the valve plug and seat ring seats

Check the valve plug and seat ring seats for damage or deterioration such as corrosion that will cause a leak from the valve seat. If a problem is found, replace the part.

● Damage to the guide caused by foreign matter

Check the guide for burrs, deformation, and damage caused by foreign matter. If a problem is found, repair or replace the part.

● Scaling in the valve body

Check the plug, inside surface of the bonnet or the seat holder, gland box, seat ring, etc., for scaling. Remove any scaling that has accumulated in the valve.

● Damage or corrosion on the inside of the gland box

Check the gland box for damage or deterioration, such as corrosion, which will cause a leak from the gland. If such problem is found, re-machine or replace the part.

● Damage or corrosion on the gasket-contacting surface

Check the gasket-contacting surface of the body, bonnet, seat holder, and lower cage for damage or deterioration, such as corrosion that will cause a leak. If a problem is found, replace the part.

Important

- **Dispose of old parts that were replaced during valve disassembly or maintenance as industrial waste. If they are burned or discarded carelessly, environmental pollution will result.**

4-2 Removing the Control Valve

This section provides instructions for removing the control valve from the equipment for a periodical inspection or other purposes.
Refer to the following instructions or cautions when removing the valve.

⚠ WARNING
Wiring should be carried out only by qualified technicians and should comply with local electrotechnical standards. Otherwise, there is a danger of electric shock.
When connecting the valve to the piping, do not put your hand or foot under the valve or between flanges. You may lose your fingers or your foot may be injured.
When assembling the valve, check that the packing (gaskets) is in place and tighten the screws evenly. If fluid leaks, it may cause injury.

Handling Precautions

- Allow enough space to work.
- Check that removal of the control valve will not affect the performance of the equipment.
- Be sure to shut off the fluid in the piping and release the process pressure.
- Check that the temperature near the control valve is normal.
- Before removing the control valve from the equipment, remove all the bolts at pipe connections to avoid applying excessive force.

■ Removing the control valve

● Removing wires

Shut off all signals and power from electric equipment that is connected to the control valve, and remove the wires.

Important

- **Avoid doing wiring work on a rainy day or in high humidity. Moisture inside the connectors or the terminal box may cause a short-circuit or rust.**
- **A packing (gasket) is attached to the cap of auxiliary equipment such as positioners. Do not lose it during wiring work.**
- **Take care not to lose screws for the cap of auxiliary equipment such as positioners.**
- **Make sure that the seal of cable glands and electrical conduits is sufficient to prevent the entry of moisture.**
- **If the eyebolts (eyenuts) attached to the actuator are used to lift the valve, make sure that the weight does not exceed the limit specified in the user's manual. An excessive load may damage the actuator or cause air leakage.**

- Removing air pipes

  Shut off the air supply to the control valve with a stop valve, etc., and remove the air pipes. Seal the ends of the removed pipes with tape, etc.

- Removal from the piping

  Secure the control valve by slinging or by other means. Then, remove bolts and nuts from the flanges and detach the control valve from the piping.

Chapter 5 Disassembly and Reassembly of the Control Valve

This section gives instructions on disassembly and reassembly of the control valve. If you need to disassemble and reassemble the valve for periodic inspection, troubleshooting, or other circumstances, refer to the instructions.

■ Before disassembly

- Allow enough space to work. If you disassemble several control valves at the same time, allow extra space to avoid mixing parts up.
- If you detach only the actuator, leaving the control valve on the piping, be sure to shut off the fluid in the piping and release the process pressure.
- Check that the temperature near the control valve is normal.
- Have all tools necessary for disassembly or detachment ready.
- Write down the information printed on the nameplate and the model No. of the positioner.

■ Necessary tools

- Hammer
- Chisel with hand guard
- Punch
- Open-end wrench or box wrench
- Special tools (a wrench for the seat ring, plug insert tool)
- Compressed air source (400 kPa max.) to test the valve.

Contact us for special tools.

5-1 Removal of the Actuator from the Valve Body and Reassembly, and Changing the Orientation of the Actuator

⚠ WARNING
Before disassembling the valve body, check that the pressure in the valve has dropped to atmospheric pressure. If fluid spews out, injury may result.
Before disassembling the valve body, wash out the inside the valve or replace the fluid. Otherwise, the residual fluid in the pipe may cause an injury.
If you detach only the actuator, leaving the valve on the piping, be sure to shut off the fluid in the piping and release the process pressure.

■ Removal of the actuator from the valve body and reassembly

● Removal procedure

Step	Procedure
1	▪ Marking With a marker, chisel with a hand guard or punch, place matching marks indicated in Figure 5-1 so that the actuator, body, and bonnet can be reassembled in the same positions.
2	▪ Detaching the stem connector Apply air pressure to the actuator so that the pointer indicates about 10 to 20 % above the fully closed position, and maintain that pressure. Loosen the hex bolts that hold the stem connector, remove the stem connector, and detach the actuator rod from the stem.
3	▪ Detaching the air pipes Detach the air pipes, etc., from the actuator. Keep supplying air from the air supply system to the actuator.
4	▪ Removing the accessories Remove accessories such as the positioner and limit switch. Protect the air supply and air output connections of the removed positioner with plastic tape, etc.
5	▪ Removing the actuator from the valve body With the hammer and chisel, loosen and remove the yoke nuts. Lift and remove the actuator from the valve body.

● Assembly procedure

Step	Procedure
1	▪ Mounting the actuator on the valve body Mount the actuator on the valve body, aligning the matching marks. Tighten the nuts that hold the yoke to secure the actuator in place.
2	▪ Attaching the accessories Attach the accessories such as the positioner and limit switch.
3	Push the plug down to set it on the seat.
4	▪ Attaching the stem connector Apply the spring range lower/upper limit air pressure to the actuator. Adjust the position of the actuator rod, and temporarily attach the stem connector. Make adjustment so that the threads on the actuator rod and stem fit properly into the threads on the stem connector. (Be careful not to rotate the stem during adjustment.) Tighten the hex bolts of the stem connector to the torque indicated in Table 6-1.
5	▪ Attaching the air pipes Attach the air pipes, etc., to the actuator.
6	▪ Readjusting the positioner Readjust the positioner (for the AVP, use the auto setup function).

■ Procedure for changing the mounting orientation of the actuator

● Procedure

Step	Procedure
1	Remove the actuator from the valve body by using the disassembly procedure in ▪ Removal of the actuator from the valve body and reassembly (p.5-2).
2	Rotate the actuator to the desired position, paying attention not to rotate the stem.
3	Assemble the valve body and the actuator by using the assembly procedure in ▪ Removal of the actuator from the valve body and reassembly (p.5-2).

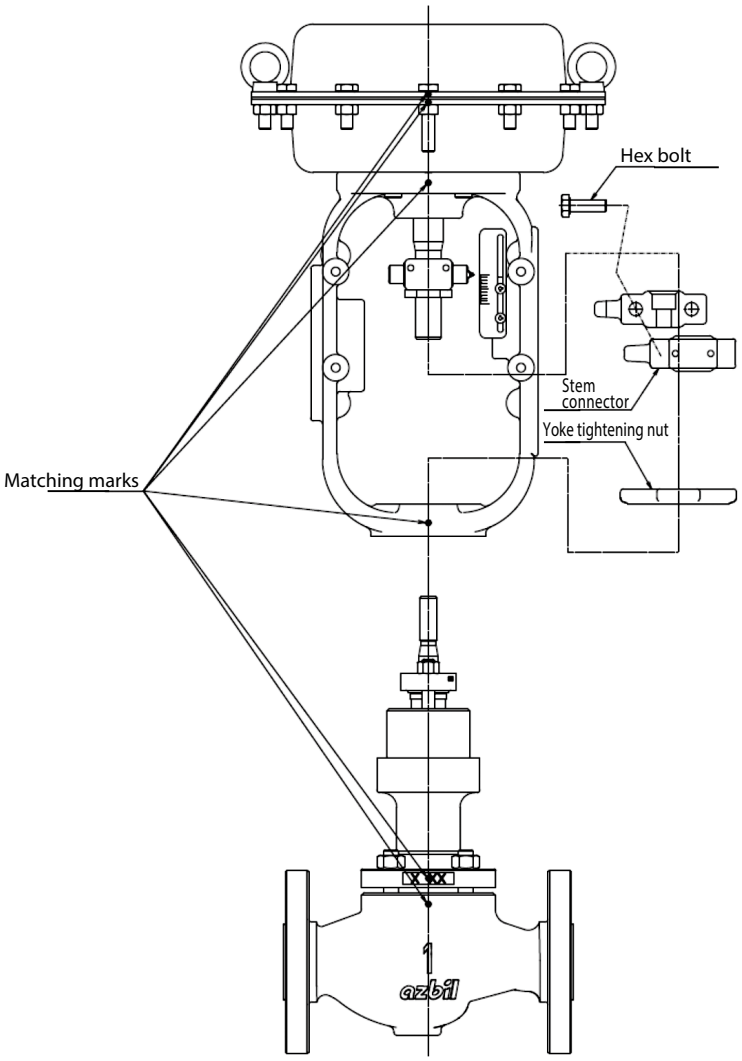


Figure 5-1. Disassembly and reassembly of the control valve

5-2 Disassembling the Valve Body

⚠ WARNING
Before disassembling the valve body, check that the pressure in the valve has dropped to atmospheric pressure. If fluid spews out, injury may result.
Before disassembling the valve body, wash out the inside the valve or replace the fluid. Otherwise, the residual fluid in the pipe may cause an injury.
If you detach only the actuator, leaving the valve on the piping, be sure to shut off the fluid in the piping and release the process pressure.

Important

- **Dispose of old parts that were replaced during valve disassembly or maintenance as industrial waste. If they are burned or discarded carelessly, environmental pollution will result.**
- **Do not remove the bonnet from the bonnet adapter.**

■ Precautions for disassembly

- Disassemble the valve body on a rag, etc., to avoid damaging the valve.
- After disassembling the valve body, protect the gasket-contacting surfaces, the plug-contacting surfaces, sliding areas, seat ring, etc., with a rag or the like.

■ Disassembly procedure

Disassemble the control valve, referring to the valve body structure illustrated in Figure 5-2 to Figure 5-5.

● Detaching the bonnet from the body

Step	Procedure
1	Loosen the nuts for the packing flange (#13).
2	With the open-end wrench or box wrench, loosen the hex nuts (#10) that hold the bonnet (#8) to the body (#1). For the bonnet for separated models, loosen the hex nuts (#10) that hold the bonnet adapter (#25) to the body (#1). Do not remove the bonnet (#8) from the bonnet adapter (#25).
3	Check if the pressure in the valve has been released completely. Remove the nuts (#10).

Step	Procedure
4	Remove the bonnet (#8) from the body (#1). Be sure to hoist the bonnet (#8) slowly and vertically by, for example, using a hoisting tool, so that the stem (#3) does not move to the side Model AS111/AS211/AS311 (nominal diameter (inch): 1 or under)Figure 5-2 If the plug (#2) comes off along with the bonnet (#8), tap the plug (#2) lightly with a plastic hammer so that it slides off from the bonnet (#8) by its own weight, taking care not to damage the seat of the stem (#3), the plug (#2) or the seat ring (#4). Model AS111/AS211/AS311 (nominal diameter (inch): 1½ to 4)Figure 5-3 If the plug (#2) and seat holder (#15) come off along with the bonnet (#8), remove them from the bonnet (#8) by turning the seat holder (#15), taking care not to damage the seat of the stem (#3), the plug (#2) or the seat ring (#4). If only the plug (#2) comes off along with the bonnet (#8), tap the plug (#2) lightly with a plastic hammer so that it slides off from the bonnet (#8) by its own weight. Model AC111/AC211/AC311 Figure 5-4, Figure 5-5, Figure 5-6 If the plug (#2) and upper cage (#17) come off along with the bonnet (#8), turn the plug (#2) and upper cage (#17) to remove them from the bonnet (#8), taking care not to damage parts such as the stem (#3). Then, remove the plug (#2) from the upper cage (#17) by pulling it up. For the AC111/AC311, note that if you remove the plug (#2) from the upper cage (#17) by pulling it down, the sealing ring (#18) or the scraper ring (#19) may be damaged.
5	Remove the gasket (#6) between the body (#1) and the bonnet (#8). For the AC111/AC211/AC311, also remove the gasket (#14) between the upper cage (#17) and the bonnet (#8).

● Removing the trim

Important

- **Before removing the trim, check whether a special tool is necessary by referring to the user's manual. If one is needed, be sure to use it. Otherwise, the trim may be damaged.**

- Model AS111/AS211/AS311 (nominal diameter (inch): 1 or under)
  After removing the plug (#2), use the special wrench to remove the seat ring (#4).
- Model AS111/AS211/AS311 (nominal diameter (inch): 1½ to 4)
  Remove the plug (#2), seat holder (#15), seat ring (#4), and spiral wound gasket (#14) from the body (#1) in this order. The seat holder (#15) has screw holes with a diameter shown in Table 5-1 for hoisting. Use the eye bolts to remove the seat holder (#15).
- Model AC111/AC211/AC311
  Remove the plug (#2), upper cage (#17), lower cage (#16), and spiral wound gasket (#14) from the body (#1) in this order. For models with 2½ in. or greater nominal diameter, the upper cage (#17) has screw holes with a diameter shown in Table 5-1 for hoisting. Use the eye bolts to remove the upper cage (#17). For the AC111 and AC311, remove the sealing ring (#18) and scraper ring (#19). For the AC211, remove the expander ring (#20) and carbon ring (#21). The carbon ring #(21) is easily broken, so handle it with care.

Table 5-1. Nominal diameter of screw holes

Model	Nominal connection diameter (inches)	Screw hole nominal diameter	Parts
AS111/AS211/AS311	1½, 2, 2½, 3	M6	Seat holder
	4	M10	
AC111/AC211/AC311	2½, 3, 4, 6	M4	Upper cage
	8	M6	

● Taking out the gland parts

Take out the gland parts with a pipe, etc. Take notes of the type, quantity, order, etc., of parts such as the packing and spacers in order to facilitate reassembly.

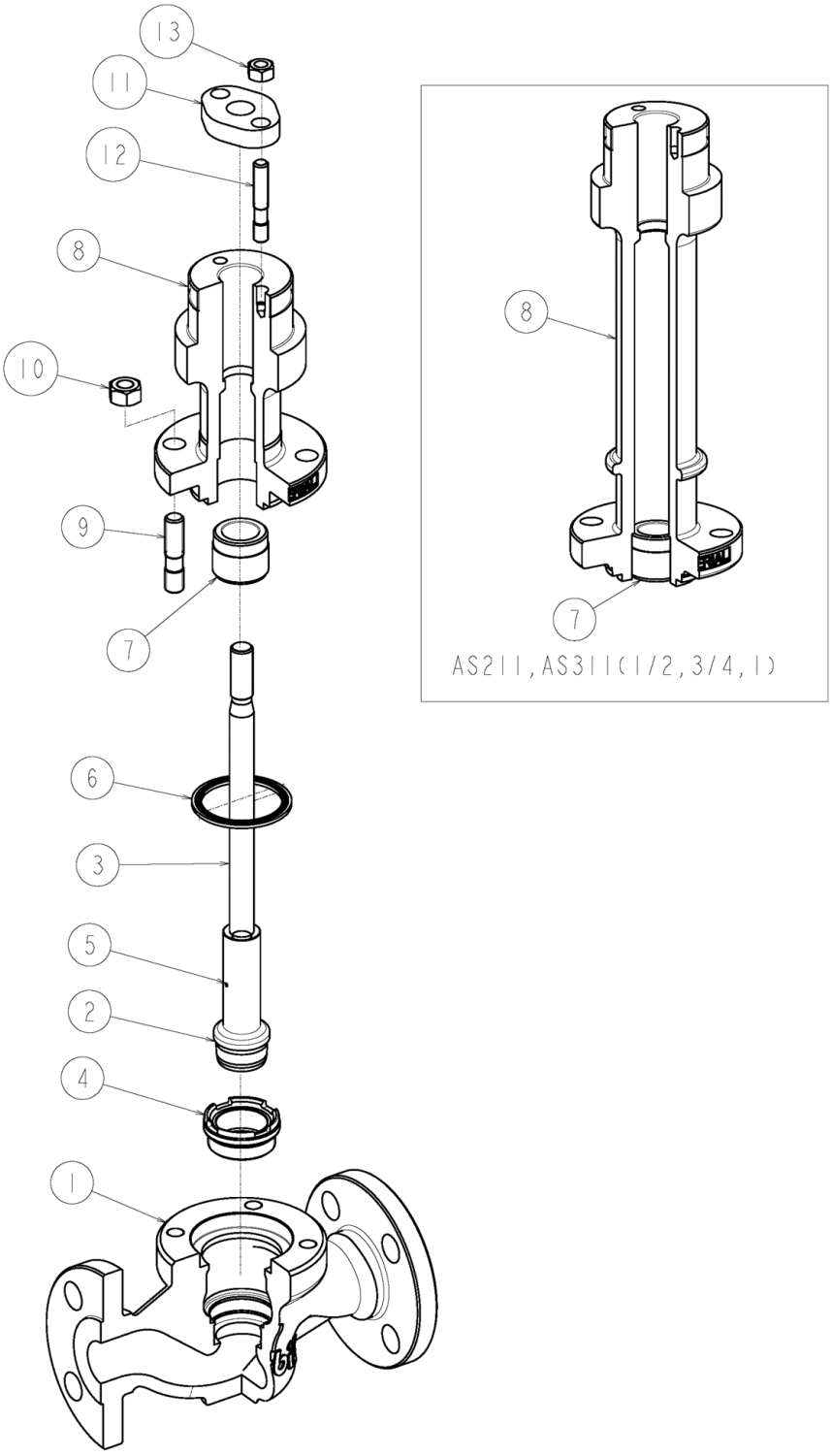


Figure 5-2. AS111/AS211/AS311 valve body structure (nominal connection diameter (inch): ½, ¾, 1)

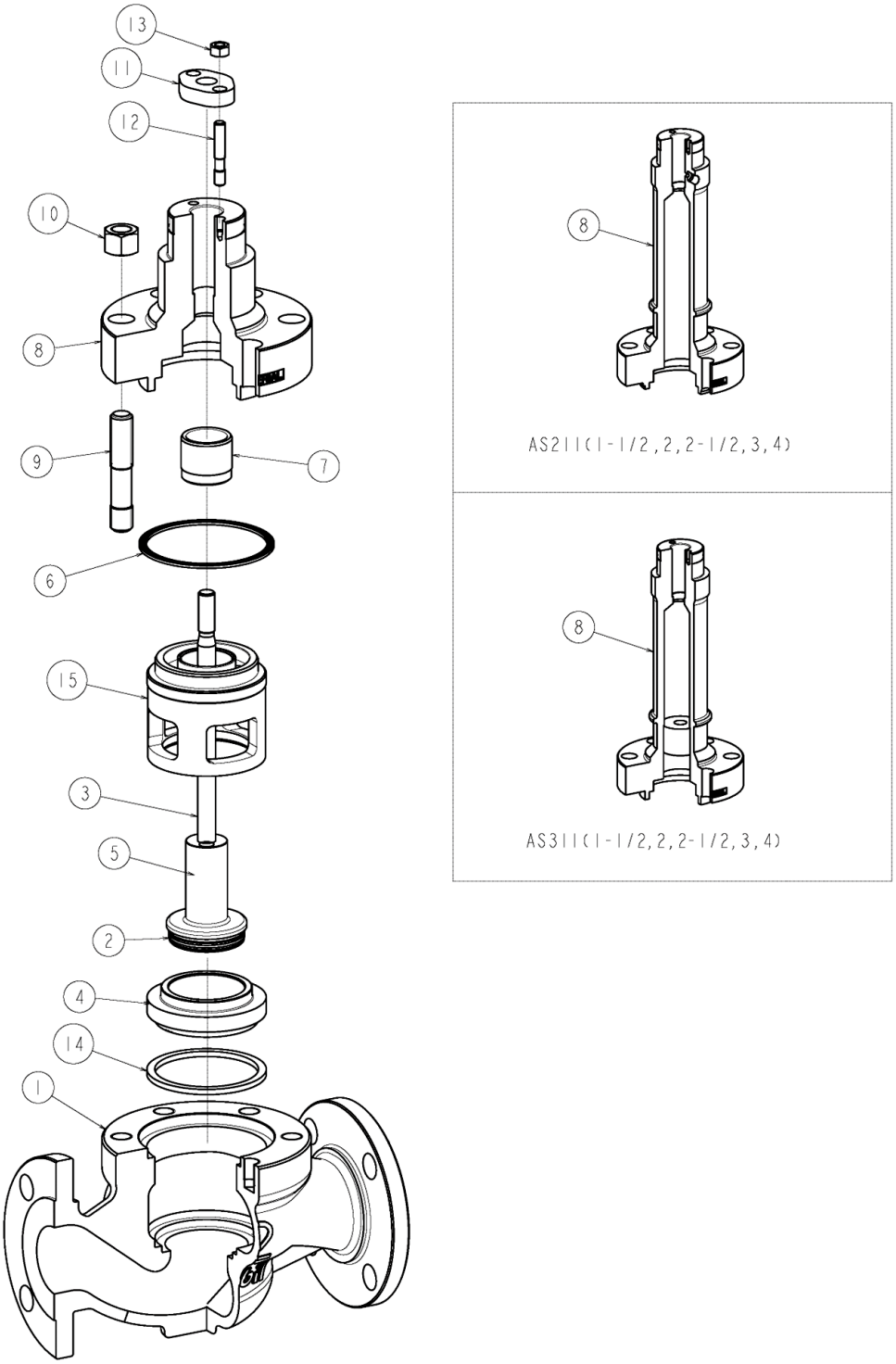


Figure 5-3. AS111/AS211/AS311 valve body structure (nominal connection diameter (inch): 1½, 2, 2½, 3, 4)

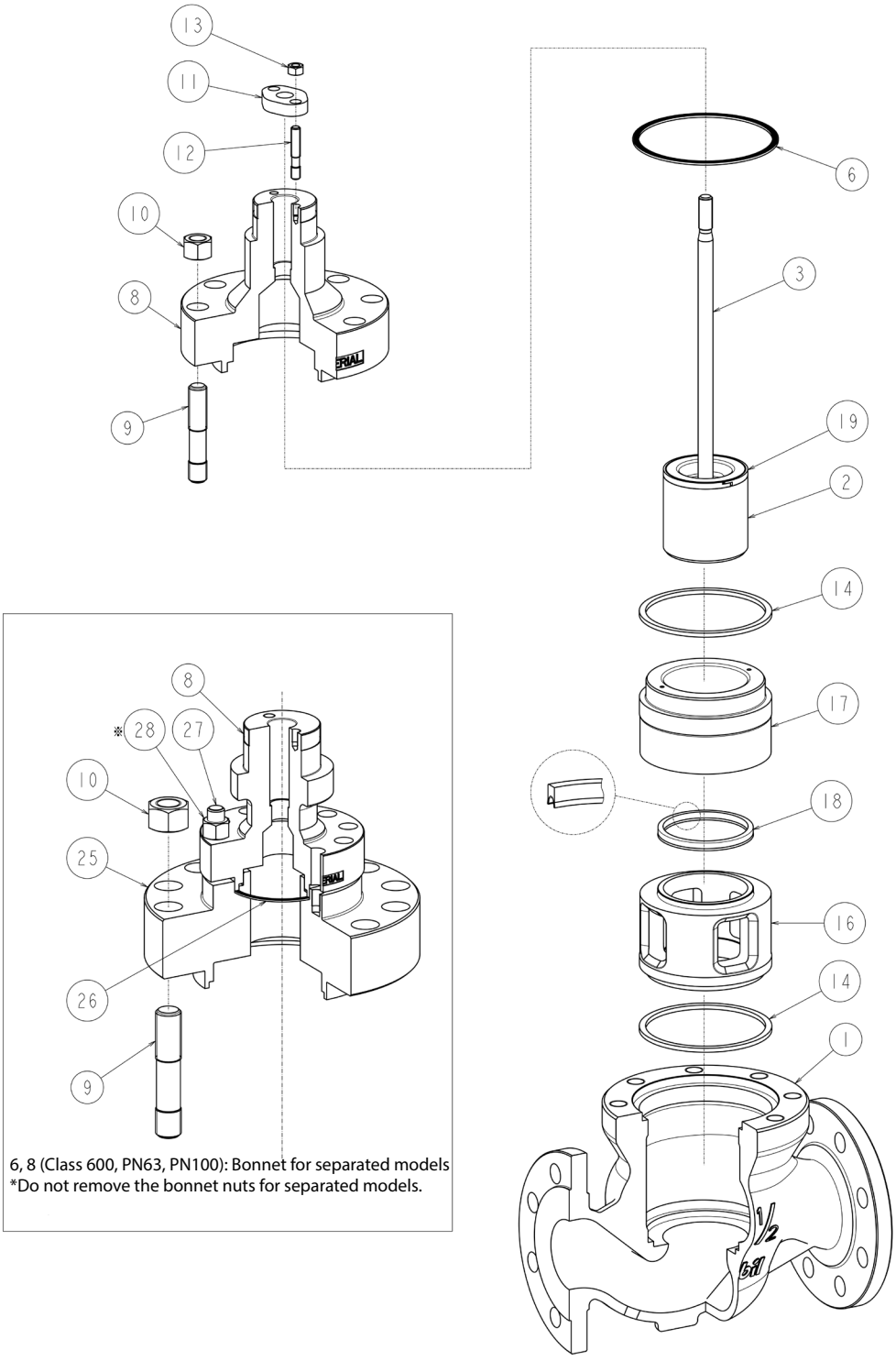


Figure 5-4. AC111 valve body structure (nominal connection diameter (inch): 1½, 2, 2½, 3, 4, 6, 8)

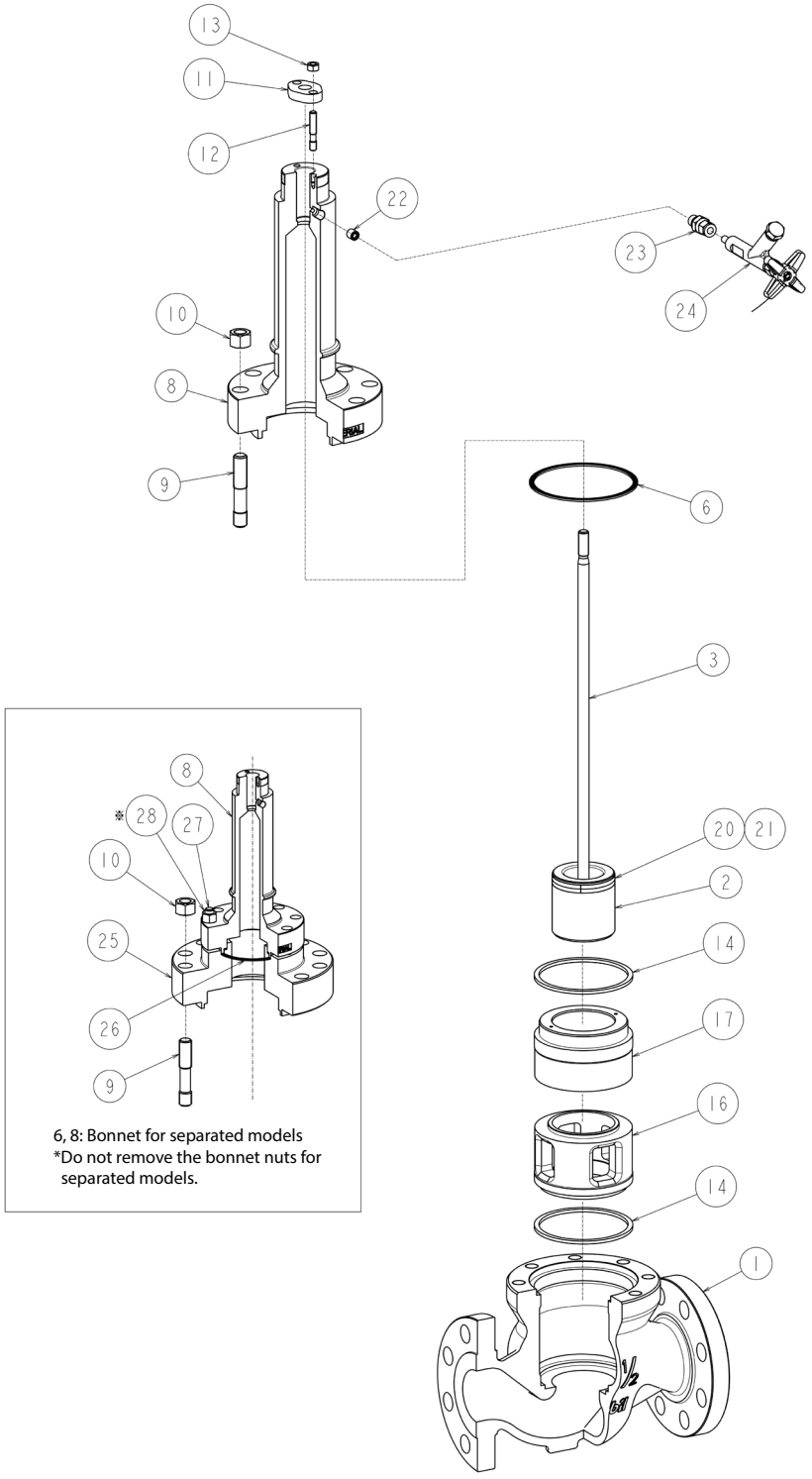


Figure 5-5. AC211 valve body structure (nominal connection diameter (inch): 1½, 2, 2½, 3, 4, 6, 8)

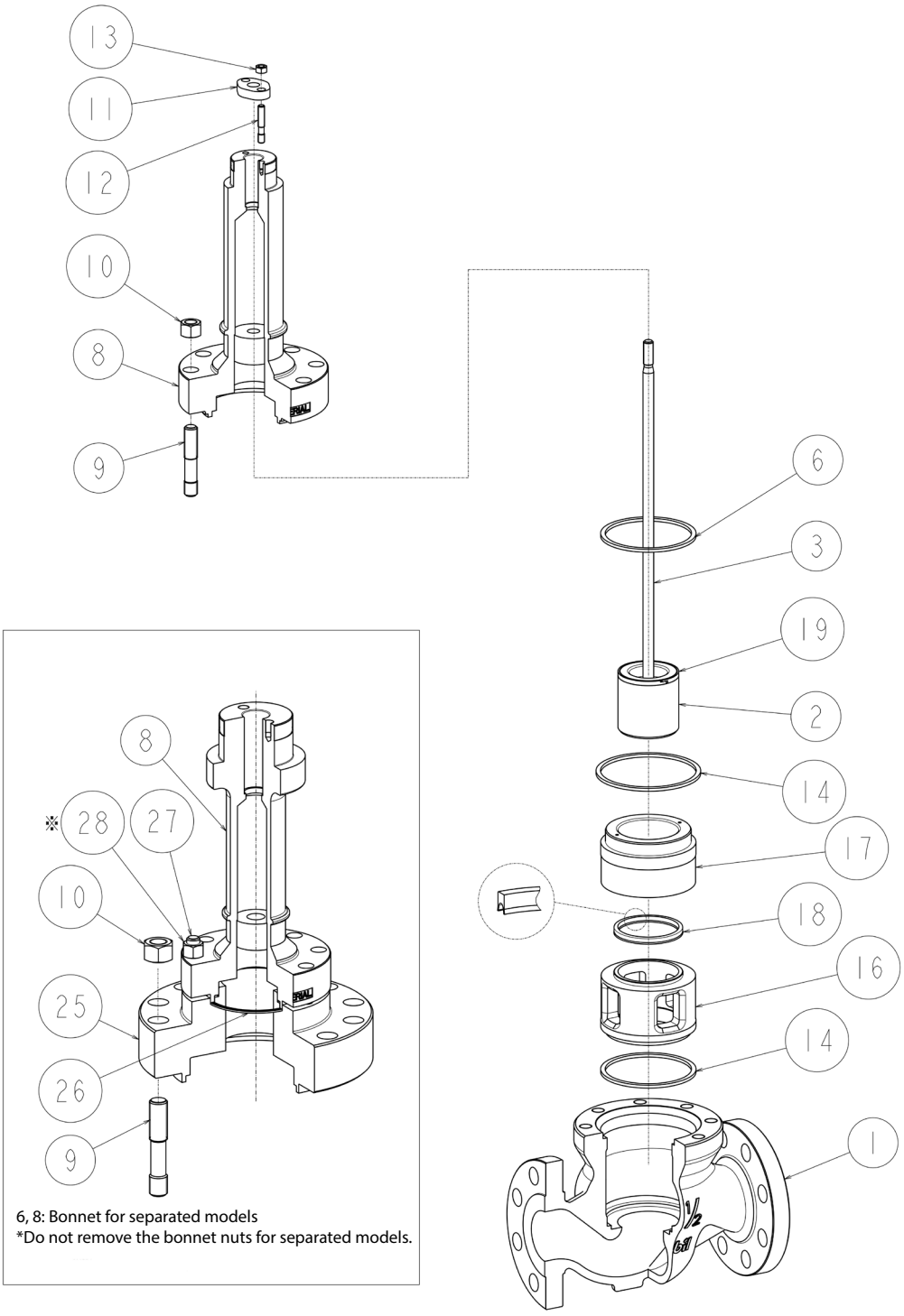


Figure 5-6. AC311 valve body structure (nominal connection diameter (inch): 1½, 2, 2½, 3, 4, 6, 8)

Key No.	Part name	Key No.	Part name
1	Body	16	Lower cage
2	Plug	17	Upper cage
3	Stem	18	Sealing ring
4	Seat ring	19	Scraper ring
5	Pin	20	Expander ring
6	Bonnet gasket	21	Carbon ring
7	Guide bushing	22	Lubricator gasket
8	Bonnet	23	Pipe fitting
9	Bonnet stud bolt	24	Lubricator
10	Bonnet hex nut	25	Bonnet adapter
11	Packing flange	26	Bonnet gasket for separated models
12	Gland stud bolt	27	Bonnet stud bolt for separated models
13	Gland hex nut	28	Bonnet nut for separated models
14	Spiral wound gasket		
15	Seat holder		

5-3 Reassembling the Valve Body

■ Precautions for assembly

- Check that there is no problem with the parts, referring to 5-2 Disassembling the Valve Body. If a problem is found, repair or replace the part as needed.
- Always use new gland packing, gaskets, sealing rings, and carbon rings.
- Note that the quantity, stacking order and direction of packing differs depending on the type of packing and fluid conditions.
- Check that foreign matter produced by maintenance do not remain inside the valve.
- For washing-restricted models (e.g., degreased or waterproof models), additional materials and sealing material with special specifications are required. Please refer to the specifications.
- If the amount of leakage from the metal seat increases, lap the contacting surfaces following the procedure below.

● Lap the contacting surfaces

Step	Procedure
1	Apply a small amount of compound* to the surface of the seat ring (#4) where the plug (#2) makes contact.
2	Mount trim parts on the body (#1). Refer to the mounting procedure for your model.
3	When mounting trim parts, use old gaskets from the removed trim. Do not mount the following parts: Model AC111/AC311 Sealing ring (#18) or scraper ring (#19) AC211 Expander ring (#20) or carbon ring (#21)
4	Mount the bonnet (#8) on the body (#1) loosely with stud bolts (9) and nuts (#10).
5	To keep the stem at the center during lapping, insert old packing into the gland.
6	Press the plug (#2) gently onto the seat ring (#4) (or the lower cage (#16)) and turn the plug (#2) to lap it (if you attach the stem connector to the top of the plug (#2), you can use it as a knob). Remove the bonnet (#8) and plug (#2) from the body (#1), and check that there are no fine scratches, etc., on the surface.
7	When lapping is complete, wipe off the compound. If the contacting surfaces are properly lapped, remove the stem connector, old packing, and old gasket. If there is a problem with the contacting surfaces, repeat from step 1.

*Use GC#600 to 800 manufactured by Fujimi Incorporated.

■ Assembly procedure

Check the nominal diameter of the pipe connection of the control valve, and reassemble the valve body referring to the valve body structure illustrated in Figure 5-2 to Figure 5-6.

● Mounting the trim

● Model AS111/AS211/AS311 (nominal diameter (inch): 1 or under)

Important

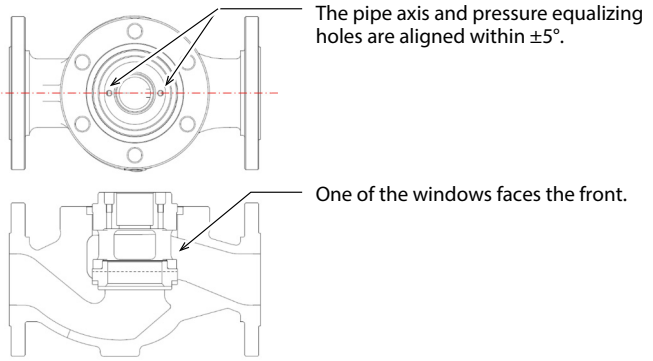
- **Before mounting the trim, check whether a special tool (e.g., a wrench for the seat ring) is necessary. If so, be sure to use one that meets the specifications.**

Step	Procedure
1	Screw the seat ring (#4) into the body (#1) with your hand. For a model with standard specifications, apply an agent to prevent galling*1 to the screws and between the body (#1) and seat ring (#4). For a degreased model, use a seat ring gasket. Apply lubricant*2 to the said locations, position the seat ring gasket, and screw the seat ring (#4) into the body.
2	Place the special wrench for the seat ring on the body (#1), and tighten the seat ring (#4) to the specified torque (133 N·m).
3	Mount the plug (#2) on the body.

*1 Use Never-Seez Pure Nickel Special made by Bostik, Inc.

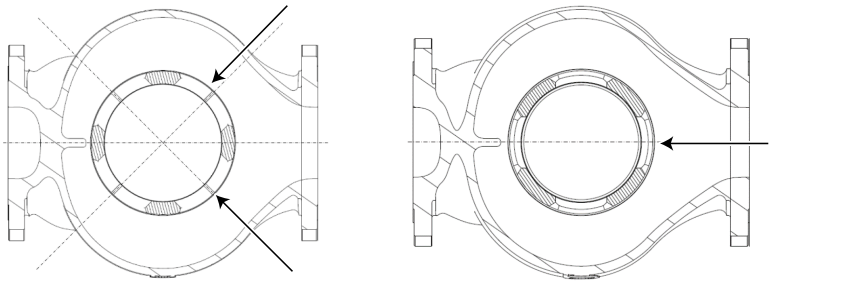
*2 Use Krytox™ GPL207 made by Chemours Corporation.

● Model AS111/AS211/AS311 (nominal diameter (inch): 1½ to 4)

Step	Procedure
1	Apply an agent for preventing galling* to a new gasket (#14) and set the gasket in place on the body (#1).
2	Mount the seat ring (#4), plug (#2), and seat holder (#15) on the body in this order.
3	Referring to the diagram below, adjust the position of seat holder (#15) windows so that one of them faces the front. 

* For a model of standard specifications, use Never-Seez Pure Nickel Special made by Bostik, Inc.
For a degreased model, use Krytox™ GPL207 made by Chemours Corporation.

● Model AC111/AC311 (nominal diameter (inch): 1½ to 8)

Step	Procedure
1	Apply an agent for preventing galling*1 to a new gasket (#14) and set the gasket in place on the body (#1).
2	Mount the lower cage (#16) on the body.
3	Adjust so that the center lines of the windows of the lower cage (#16) are positioned as shown in the figures below. Size 8 in.: 45° ±10° to the pipe axis Size 6 in.: ±10° to the pipe axis Size 4 in. or under: ±5° to the pipe axis : Center of lower cage windows  Size 8 in.: 45°±10° Size 6 in.: ±10°, size 4 in. or under: ±5°
4	Apply a thin layer of lubricant*2 to the entire outer surface of the sealing ring (#18) and set it into the groove of the upper cage (#17). Then, mount the upper cage (#17) onto the lower cage (#16) inside the body (#1). For the orientation of the sealing ring (#18), refer to Figure 5-4.
5	Apply a thin layer of lubricant*2 to the entire surface of the scraper ring (#19) and set it into the groove at the top of the plug (#2). Then, insert the plug (#2) into the upper cage (#17) and lower cage (#16). Push the plug (#2) evenly through the sealing ring (#18) until the metal at the tip of the plug (#2) makes contact with the metal of the seat of the lower cage (#16).

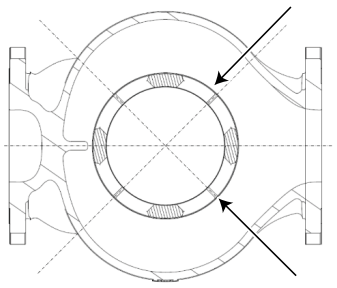
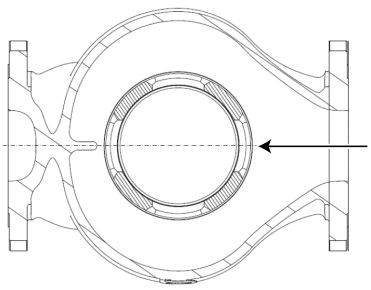
*1 For a model of standard specifications, use Never-Seez Pure Nickel Special made by Bostik, Inc.
For a degreased model, use Krytox™ GPL207 made by Chemours Corporation.

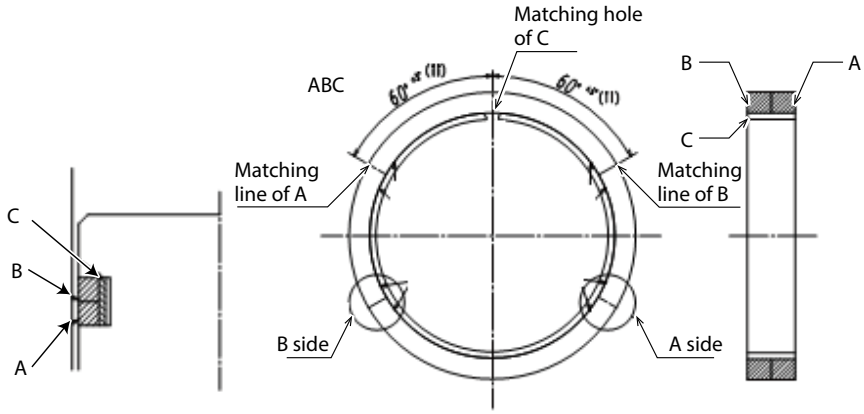
*2 For a degreased model, use G40M silicone grease made by Shin-Etsu Chemical Co., Ltd.
For a degreased model, use Krytox GPL207 made by Chemours Corporation.

● Model AC211 (nominal diameter (inch): 1½ to 8)

Important

- **Before mounting the trim, check whether a special tool (e.g. a plug insert tool) is necessary. If so, be sure to use one that meets the specifications.**

Step	Procedure
1	Apply an agent for preventing galling* to a new gasket (#14) and set the gasket in place on the body (#1).
2	Mount the lower cage (#16) on the body.
3	Adjust so that the center lines of the windows of the lower cage (#16) are positioned as shown in the figures below. Size 8 in.: 45° ±10° to the pipe axis Size 6 in.: ±10° to the pipe axis Size 4 in. or under: ±5° to the pipe axis : Center of lower cage windows  Size 8B in.: 45°±10°  Size 6B in.: ±10°, size 4B in.: ±5°
4	Mount the upper cage (#17) on the lower cage (#16) in the body (#1).

Step	Procedure
5	Set the expander ring (#20) and carbon rings (#21) into the groove at the top of the plug (#2), following instructions i and ii below. Apply an agent for preventing galling*1 to the surface of the carbon rings (#21). i) Align the matching marks indicated on each carbon ring (#21). ii) Shift the matching line of A, matching hole of C, and matching line of B by 60° ±5° each.  A, B: Carbon ring C: Expander ring
6	Insert the plug (#2) into the upper cage (#17) and lower cage (#16). Push the plug (#2) until the metal at the tip of the plug (#2) makes contact with the metal of the seat of the lower cage (#16). For a body with 4 in. or greater nominal diameter, use a plug insert tool.

* For a model of standard specifications, use Never-Seez Pure Nickel Special made by Bostik, Inc.

● Mounting the bonnet

⚠ WARNING

Because damaged or corroded bolts and nuts may damage the valve and cause injury, replace them with new ones.

When reassembling the valve body, always use new packing and gaskets. The reuse of old parts will cause fluid leakage.

● Model AS111/AS211/AS311/AC111/AC211/AC311

Important

- **Observe the tightening torques indicated in the user's manual when tightening bolts and nuts.**
- **Tighten the nuts for connecting the bonnet to the body evenly in a diagonal pattern.**

Step	Procedure
1	Apply an agent for preventing galling* to a new bonnet gasket (#6) and set the gasket (#6) in place on the body (#1). AC111/AC211/AC311: Apply an agent for preventing galling* also to a new spiral wound gasket (#14) and set the gasket (#14) in place on the upper cage (#17).
2	Mount the bonnet (#8) on the body (#1). Be sure to align the matching marks, which were made on the body(#1) and bonnet (#8) before disassembly, in order to set them in the right position.
3	Apply an agent for preventing galling* to the threads of the bonnet stud bolts (#9). Mount the bonnet (#8) to the body (#1) and tighten the bonnet hex nuts (#10) using a wrench. When tightening the bonnet hex nuts (#10), do so gradually and evenly in a diagonal pattern to the torque specified in Table 5-2. Use the procedure below. i. Tighten them in a diagonal pattern to 20 N·m or 2 % of the specified torque (once). ii. Tighten them in a diagonal pattern to 30 % of the specified torque (once). iii. Tighten them in a diagonal pattern to 60 % of the specified torque (once). iv. Tighten them in a diagonal pattern to 100 % of the specified torque (once). v. Tighten them clockwise to 100 % of the specified torque (repeat until the nuts do not turn anymore).

* For a model of standard specifications, use Never-Seez Pure Nickel Special made by Bostik, Inc.
For a degreased model, use Krytox™ GPL207 made by Chemours Corporation.

Table 5-2. Bonnet hex nut tightening torque

Nominal connection diameter (inches)	Rated pressure	Bonnet hex nut nominal diameter × quantity	Tightening torque (N·m)
½, ¾, 1	Class150 Class300 PN10, PN16, PN25, PN40	M10 × 4	23
	Class600 PN63, PN100	M12 × 6	40
1½, 2	Class150 Class300 PN10, PN16, PN25, PN40	M16 × 6	99
	Class600 PN63, PN100	M16 × 8	99
2½, 3 (6: bonnet for separated models)	Class150 Class300 PN10, PN16, PN25, PN40	M16 × 8	99
	Class600 PN63, PN100	M20 × 10	162
4 (8: bonnet for separated models)	Class150 Class300 PN10, PN16, PN25, PN40	M20 × 8	162
	Class600 PN63, PN100	M22 × 12	222
6	Class150 Class300 PN10, PN16, PN25, PN40	M22 × 12	222
	Class600 PN63, PN100	M30 × 12	453
8	Class150 Class300 PN10, PN16, PN25, PN40	M24 × 12	280
	Class600 PN63, PN100	M30 × 16	453

● Assembling the gland

● Preparation for assembly

Step	Procedure
1	Any flaw or the like on the surface of the parts may cause leakage from that area, and the specified seal performance may not be achieved. Therefore, check the surface of the parts indicated in Table 5-3.
2	When assembling or reassembling, for the parts indicated in Table 5-4, be sure to use new parts.
3	Have an appropriate amount of the lubricant indicated in Table 5-5 on hand.

Table 5-3. Parts to be checked for surface condition

Part name	Checkpoints	Possible problems
Stem	●No flaws or defects, including scratches and dents ●No rust or corrosion ●The entire surface is even. ●No burrs	Any flaw, rust, corrosion, burrs, dirt, etc., may cause leakage from that area, and the specified seal performance may not be achieved.
Stuffing box		
Both ends of the spacer		
Packing follower (packing contact surface)		
Packing flange (gland nut contact surface)	●Clean surface, with no adhering coating material, powder, or dirt. ●If necessary, take necessary measures such as cleaning with alcohol.	Any flaw, rust, corrosion, burrs, dirt, etc., may cause insufficient tightening, and the specified seal performance may not be achieved.
Packing flange (entire surface)	●No flaws, rust, or defects	Any flaw, rust, defect, etc., may cause control valve damage, leading to injuries.
Gland stud bolt		
Gland nut		

Table 5-4. Parts requiring replacement

Part name	Checkpoints	Possible problems
Gland packing	●No flaws. No coating materials or dirt stuck to the surface.	Any flaw, coating material, dirt, etc., may cause leakage from that area, and the specified seal performance may not be achieved.
Belleville spring (low-emission gland packing)		Any flaw, coating material, dirt, etc., may cause insufficient tightening and leakage from the gland in a short period of time, and the specified seal performance may not be achieved.

Table 5-5. Lubricant

Product name	Applied area	Packing type
G40M silicone grease made by Shin-Etsu Chemical Co., Ltd.	Entire surface of the gland packing	General gland packing PTFE yarn, V-shaped PTFE, V-shaped PTFE (direct + reversed), V-shaped PTFE-H
Krytox™ GPL207 fluoropolymer grease made by Chemours Corporation	Entire surface of the gland packing	General gland packing P6617CL+P6720 Low-emission gland packing P4519+P6720, P6617CL+P6720
One of the following greases made by Climax Lubricants and Equipment Co.: Polyseal #6, 650, 400, 800	Entire surface of the gland packing	P6610CH + M8590

● Assembly

⚠ WARNING

Because damaged or corroded bolts and nuts may damage the valve and cause injury, replace them with new ones.

Important

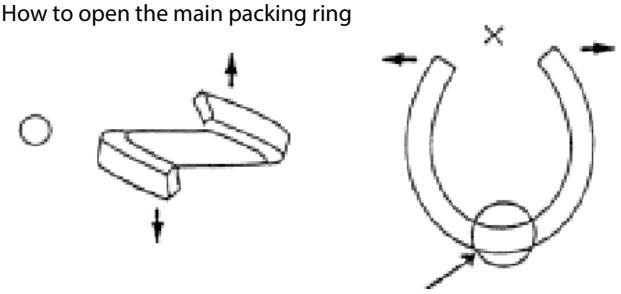
- **Observe the tightening torques indicated in the user's manual when tightening bolts and nuts.**
- **Tighten the nuts for connecting the bonnet to the body evenly in a diagonal pattern.**

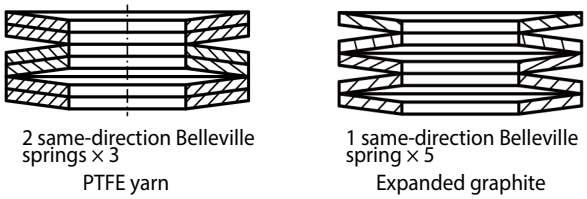
Table 5-6. General gland packing

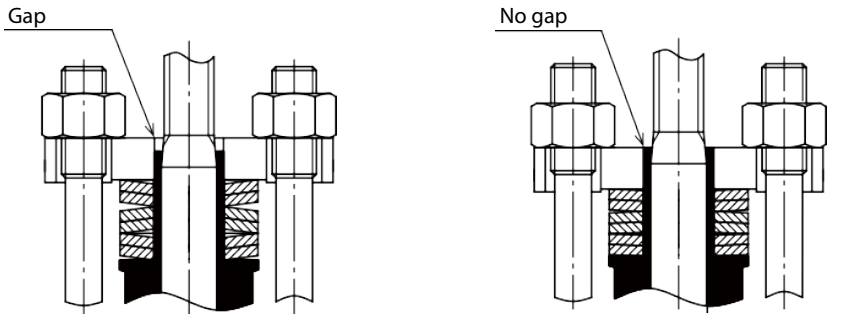
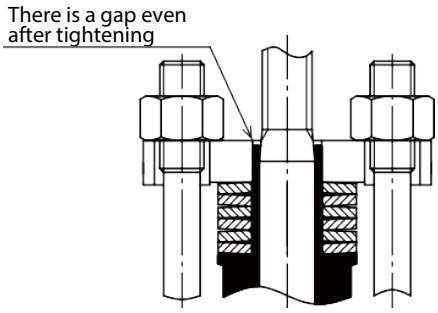
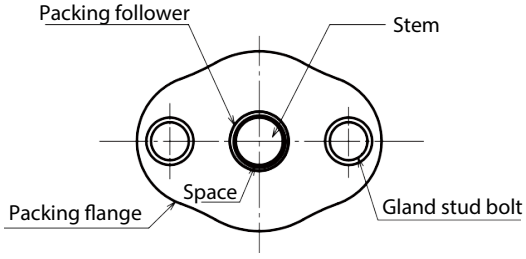
Step	Procedure
1	Apply a thin layer of the grease shown in Table 5-5 to the entire surface of the gland packing.
2	Insert the parts of the gland in the right order, referring to the notes that were taken during disassembly and to the figure in Figure 5-7, which illustrates the structure of the gland. Insert the parts all the way to the bottom with a pipe, etc. If PTFE yarn packing is used, insert it with the cut part of the packing shifted by 180°.
3	Apply an agent for preventing galling* to the gland stud bolts (#12) and hex nuts (#13) Tighten the packing flange (#11) with the gland stud bolts (#12) and hex nuts (#13) to the torque specified in Table 5-8.

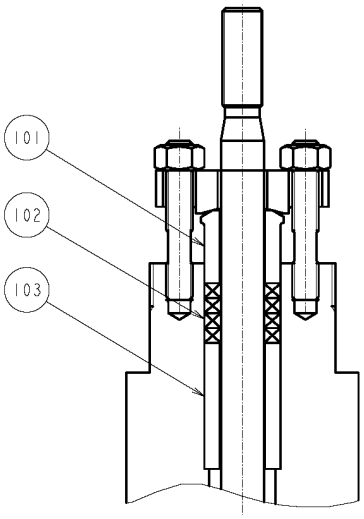
* Use Never-Seez Pure Nickel Special made by Bostik, Inc.

Table 5-7. Low-emission gland packing

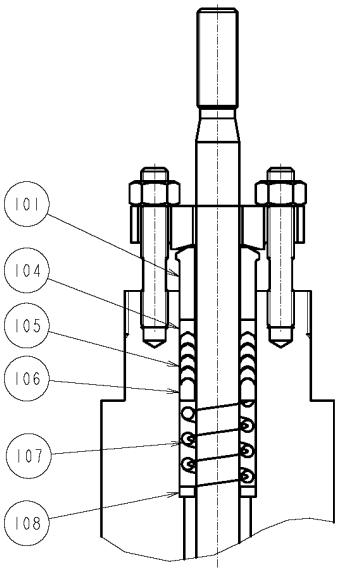
Step	Procedure
1	Apply a thin layer of the grease shown in Table 5-5 to the entire surface of the gland packing.
2	Insert the spacer (#103) by referring to Figure 5-8.
3	Carefully insert the carbon ring (#115) all the way to the bottom with a pipe, etc., taking care not to damage the ring.
4	<u>PTFE yarn</u> Insert one adapter packing ring (#114), without opening the gap, all the way to the bottom with a pipe, etc., and push it lightly. Insert one of the main packing rings (#102). Be sure to open the ring in the manner illustrated in the figures below. Insert the packing ring all the way to the bottom with a pipe, etc., and push it lightly. Insert the remaining two main packing rings with the position of the gap shifted by 180° each time. How to open the main packing ring  Insert one adapter packing ring (#114), without opening the gap, all the way to the bottom with a pipe, etc., and push it lightly. <u>Expanded graphite</u> Insert one adapter packing ring (#114), without opening the gap, all the way to the bottom with a pipe, etc., and push it lightly. Insert one of the main packing rings (#113). with the marking facing upward, all the way to the bottom with a pipe, etc., and push it lightly. Insert the remaining two main packing rings in the same manner. Insert one adapter packing ring (#114), without opening the gap, all the way to the bottom with a pipe, etc., and push it lightly.
5	Gently insert the carbon ring (#115) all the way to the bottom with a pipe, etc., taking care not to damage the ring.
6	Check the correct mounting orientation of the packing follower (#101) in Figure 5-8 and insert it.

Step	Procedure
7	Stack the Belleville springs (#119) as shown in the figures below, and insert them into the packing follower (#101).  2 same-direction Belleville springs × 3 PTFE yarn 1 same-direction Belleville spring × 5 Expanded graphite
8	Place the packing flange (#11) onto the packing follower (#101).
9	Apply an agent to prevent galling* to the gland stud bolts (#12) and to the gland hex nuts (#13), and screw the nuts on by hand.
10	Tighten the left and right gland hex nuts (#13) alternately, making approximately a half turn each, until the torque indicated in Table 5-8 is reached. Note that if the tightening torque is insufficient, the specified seal performance may not be achieved. On the other hand, tightening the gland nuts with excessive torque increases the friction on the stem and causes the gland packing (main packing and adapter packing) to wear out faster, which may lead to an amount of leakage exceeding the specified value in a short period of time.

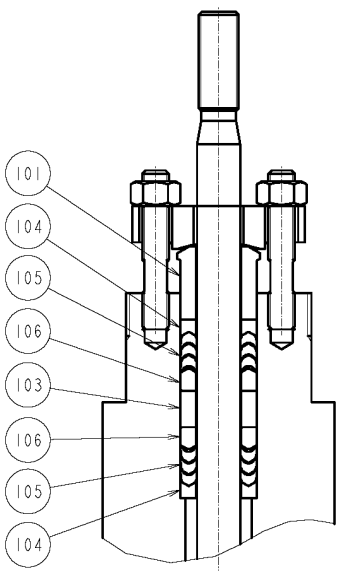
Step	Procedure
11	By tightening the gland nuts to the torque indicated in table 5-7, the top of the packing flange (#11) and packing follower (#101) will be at almost the same level as illustrated in the figures below (the level may not be exactly the same due to the tolerance of the Belleville springs (#119) and friction on the gland stud bolts (#12) or gland hex nuts (#13)). If the Belleville springs (#119) are mounted in the wrong direction, or if the gland nuts are tightened to a torque that does not comply with the torque specified in table 5-7, the level of the top of the packing flange (#11) and packing follower (#101) will not be the same (see the figures below). Check if the direction of the Belleville springs (#119) and the tightening torque are correct.  Load on Belleville springs (correctly assembled)  Load on Belleville springs (incorrectly assembled)
12	View the assembly from above to check that the space between the stem (#3) and the packing follower (#101) is even.  Top view



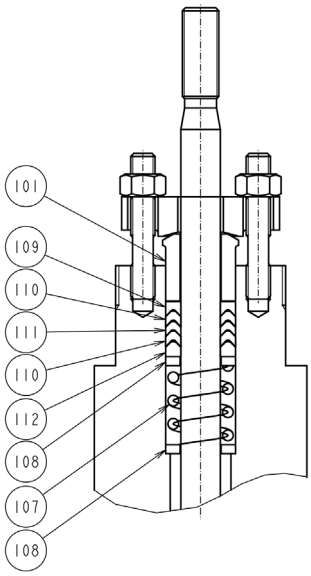
PTFE yarn



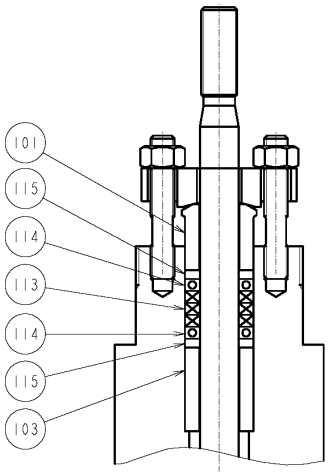
V-shaped PTFE



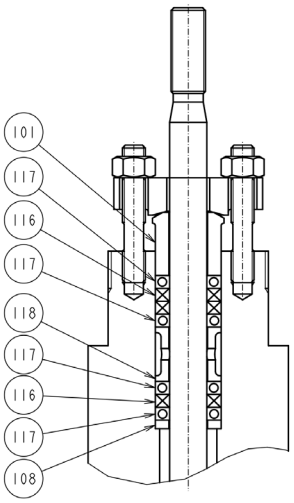
V-shaped PTFE (direct + reversed)



V-shaped PTFE-H

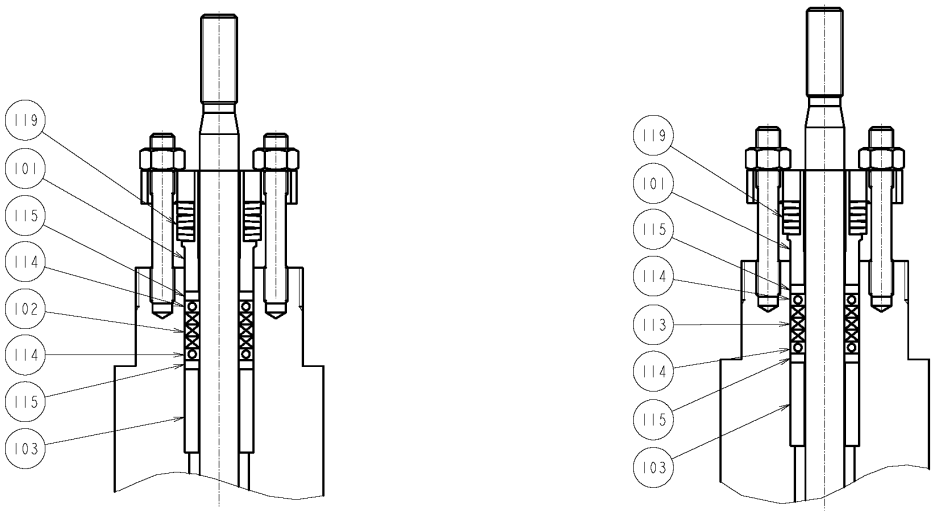


P6617CL + P6720



P6610CH + M8590

Figure 5-7. Gland structure (general gland packing)



PTFE yarn
P4519 + P6720

Expanded graphite
P6617CL + P6720

Figure 5-8. Gland structure (low-emission gland packing)

Key No.	Part name	Key No.	Part name
101	Packing follower	111	V-PTFE adapter packing for high pressure
102	PTFE yarn packing	112	V-PTFE adapter packing for high pressure (bottom)
103	Packing spacer	113	Graphite main packing (P6617CL)
104	V-PTFE packing holder	114	Graphite adapter packing (P6720)
105	V-PTFE packing	115	Carbon ring
106	V-PTFE packing retainer	116	Graphite main packing (P6610CH)
107	Gland spring	117	Graphite adapter packing (M8590)
108	Packing ring	118	Lantern ring
109	V-PTFE adapter packing for high pressure (top)	119	Belleville spring
110	V-PTFE main packing for high pressure		

Table 5-8. Packing flange hex nut tightening torque (N·m)

Gland packing type		Valve stem size (nut nominal diameter × quantity)	
		φ13 (M8 × 2)	φ20 (M14 × 2)
General gland packing	PTFE* yarn	7	23
	V-shaped PTFE*	1	4
	V-shaped PTFE* (direct + reversed)	7	23
	V-shaped PTFE*-H	1	4
	Expanded graphite (P6617CL+P6720)	1	4
	Expanded graphite (P6610CH+M8590)	7	23
Low-emission gland packing	PTFE* yarn	11	35
	Expanded graphite (P6617CL+P6720)	11 → 0 (loosen) → 7	35 → 0 (loosen) → 23

*Polytetrafluoroethylene

Note: The torque may vary depending on the type of packing. Use the indicated torque as a rough guideline.

Chapter 6 Disassembly and Reassembly of Model PA Actuator

6-1 Disassembly of the Actuator

■ Precautions for disassembly

⚠ WARNING

Do not disassemble the pneumatic actuator while supply air pressure is being applied. The compressed air may cause an injury.

Important

- **Dispose of old parts that were replaced during valve disassembly or maintenance as industrial waste. If they are burned or discarded carelessly, environmental pollution will result.**

- The hex bolts that connect the diaphragm case and yoke are carbon steel. Do not mix them with other bolts.
- Place the removed parts in a clean place.
- Stand the actuator up vertically during disassembly.
- For actuators that are equipped with a side handlheel, refer to「6-4 Removing the Side Handwheel from the Actuator」.
- Release the air in the diaphragm case before disassembly.

■ Disassembly procedure

⚠ WARNING

For an actuator that incorporates compressed coil springs, follow the disassembly procedure when removing bolts, nuts, etc. Otherwise, the diaphragm cases or compressed coil springs may pop out, causing injury.

Important

- **Do not use an impact wrench to loosen hex nuts (#203) for long hex bolts (#216), as it may cause thread galling.**

Check the size of the actuator and disassemble it, referring to Figure 6-1 to Figure 6-5.

● Marking and protection

Step	Procedure
1	Place matching marks on the upper diaphragm case (#213), the lower diaphragm case (#217), and the boss of the yoke (#228) for remounting the diaphragm cases.
2	Wrap plastic tape around the threads of the rod (#220) to protect the sealing parts and the bushing.

● Removing bolts and nuts from the diaphragm cases

Step	Procedure
1	Loosen and remove hex nuts (#203) that are not used for the long hex bolts (#216).
2	Loosen each hex nut (#203) for the long hex bolts (#216) evenly, little by little. Do not use an impact wrench, as it may cause galling.
3	After confirming that the compressed coil springs (#204) are fully extended and no torque is applied to the hex nuts, remove the hex nuts.

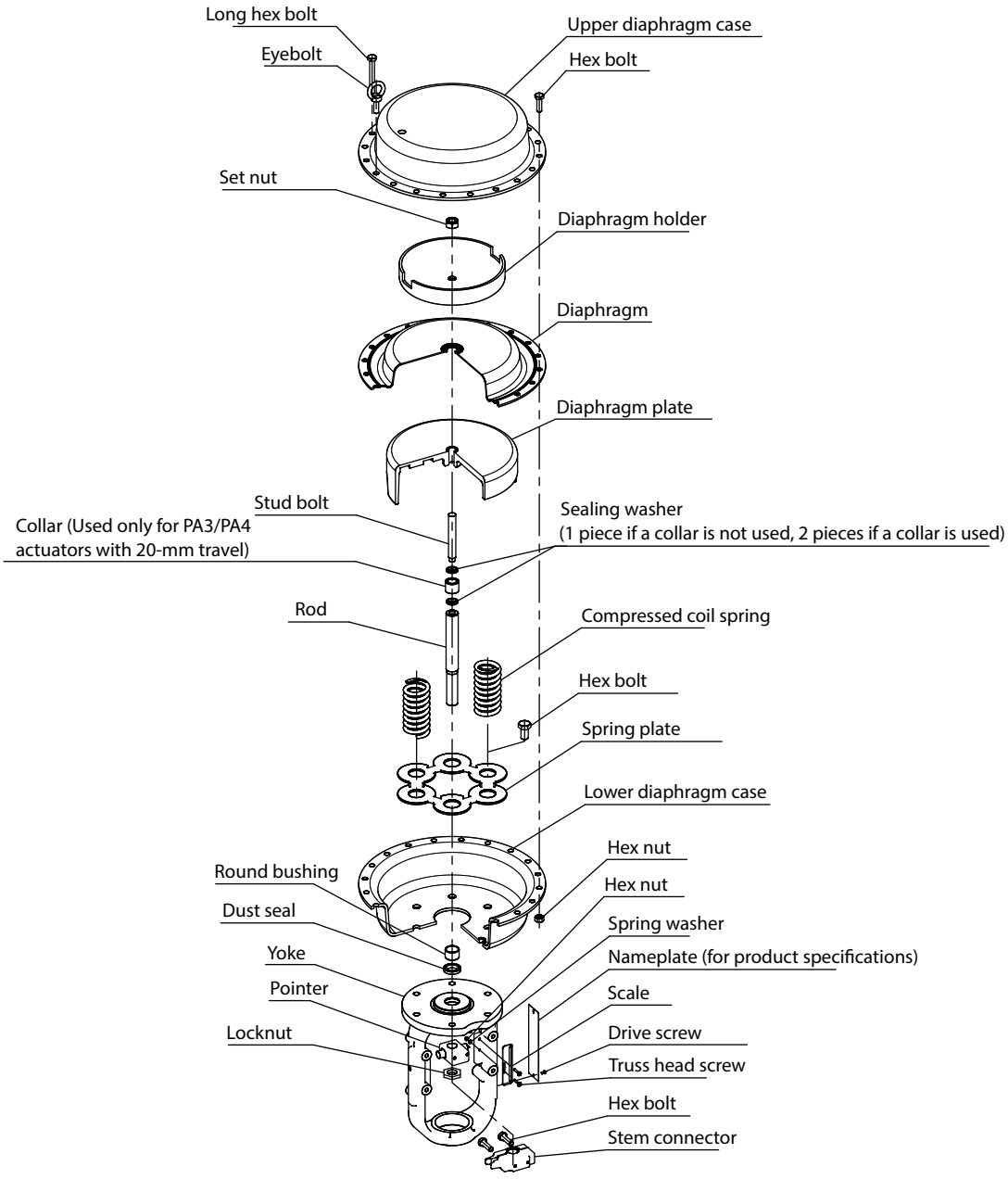


Figure 6-1. Direct action (PA2–4)

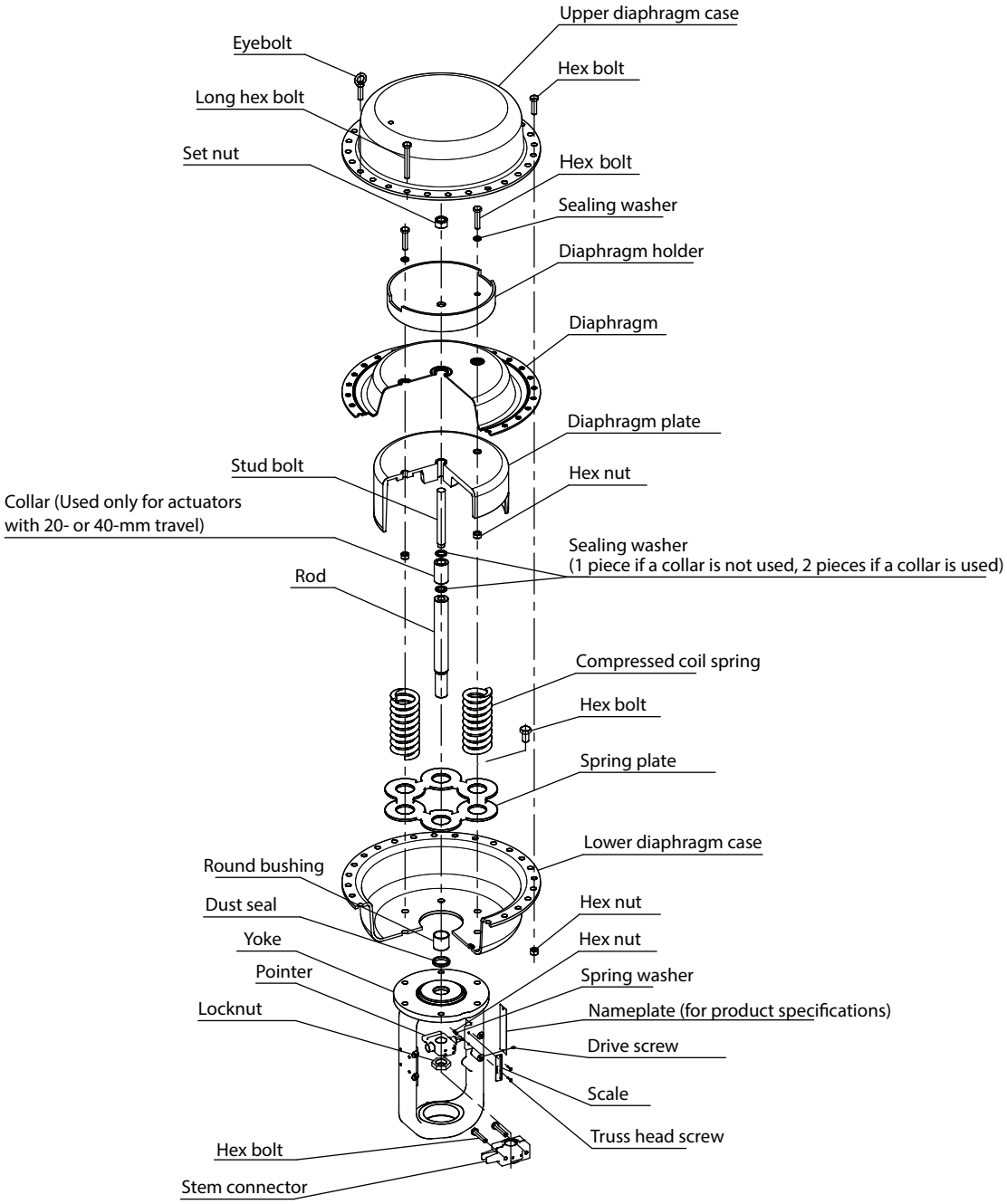


Figure 6-2. Direct action (PA5)

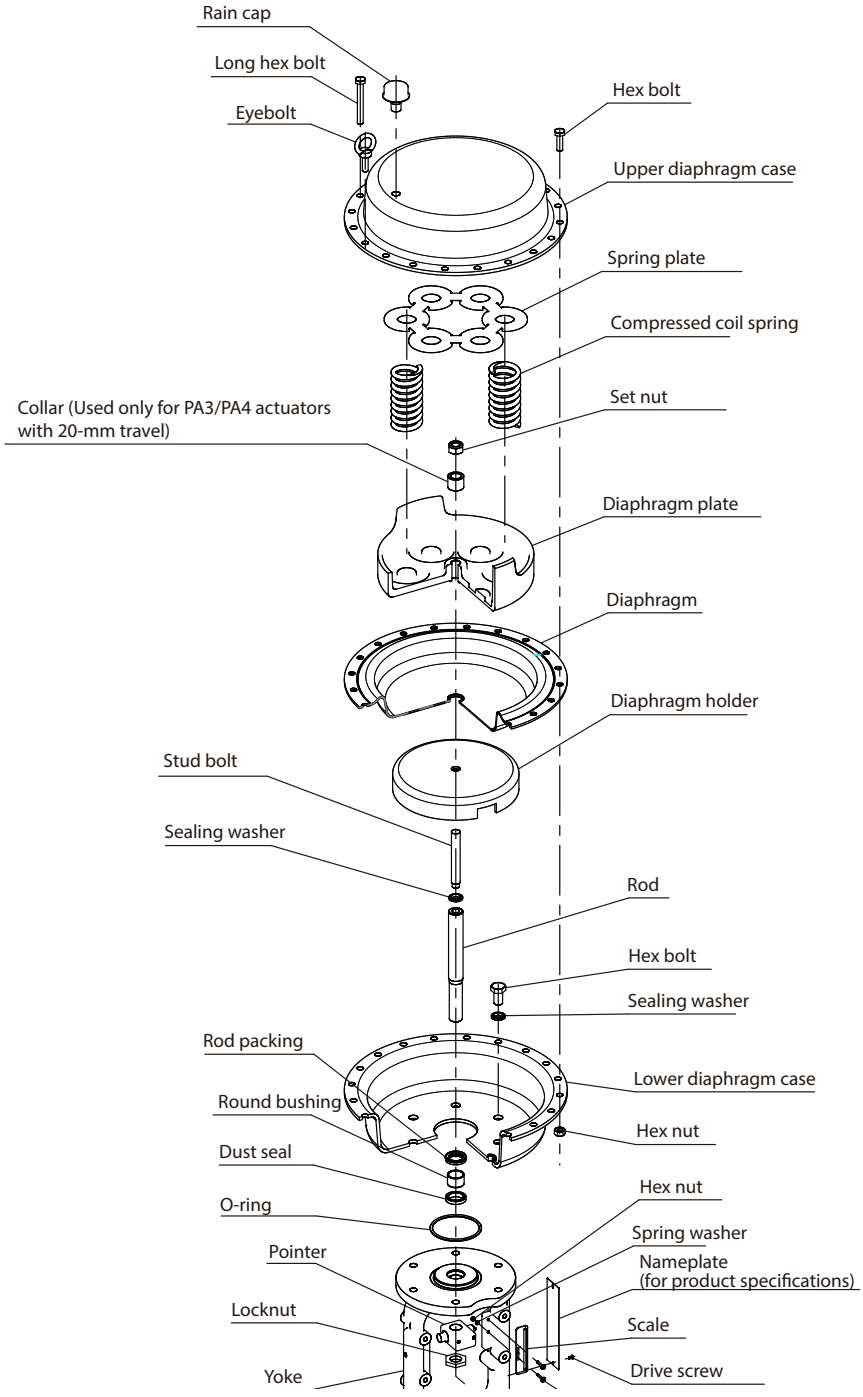


Figure 6-3. Reverse action (PA2–4)

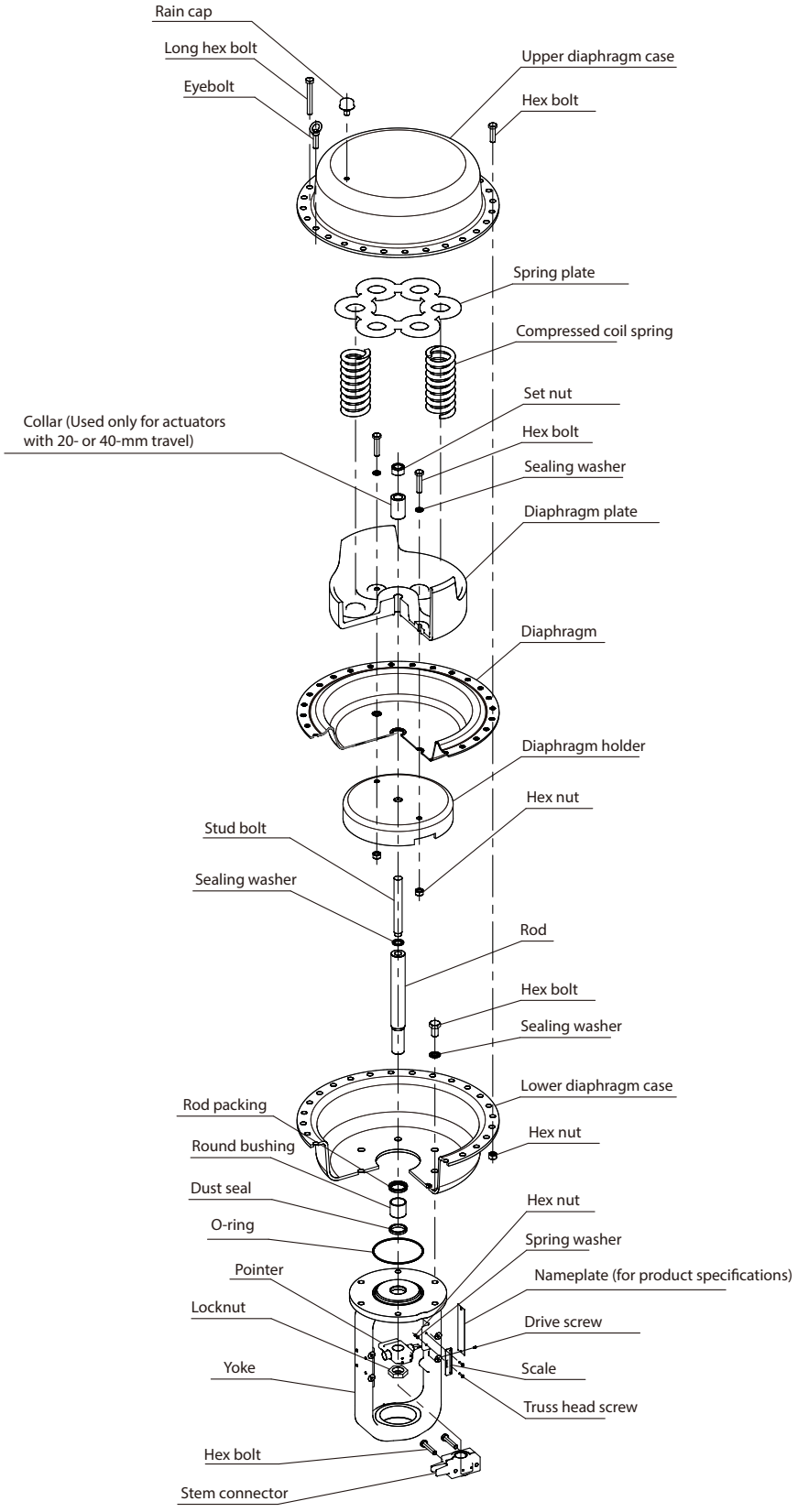
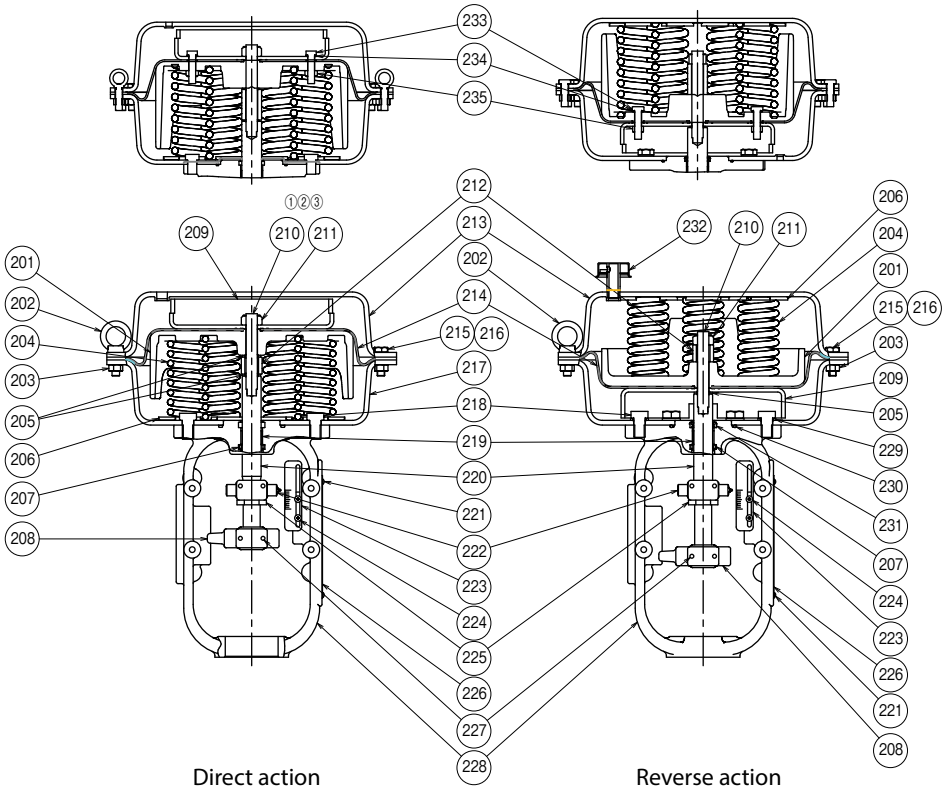


Figure 6-4. Reverse action (PA5)



No.	Part name	No.	Part name	No.	Part name	No.	Part name
201	Diaphragm plate	210	Stud bolt	219	Round bushing	228	Yoke
202	Eyebolt	211	Set nut	220	Rod	229	Sealing washer
203	Hex nut	212	Collar	221	Drive screw	230	O-ring
204	Compressed coil spring	213	Upper diaphragm case	222	Pointer	231	Rod packing
205	Sealing washer	214	Diaphragm	223	Scale	232	Rain cap
206	Spring plate	215	Hex bolt	224	Truss head screw	233	Hex nut (PA5 only)
207	Dust seal	216	Long hex bolt	225	Locknut	234	Sealing washer (PA5 only)
208	Stem connector	217	Lower diaphragm case	226	Nameplate	235	Set nut (PA5 only)
209	Diaphragm holder	218	Hex bolt	227	Hex bolt		

Figure 6-5. Structure of the PA actuator

● Removing the upper diaphragm case and the diaphragm unit

Step	Procedure
1	Remove the upper diaphragm case (#213).
2	Remove the hex bolts (#227) from the stem connector (#208). Then, remove the stem connector (#208), the locknut (#225), and the pointer (#222) from the rod (#220). (If the actuator is mounted on the valve body, refer to the procedure for removing the stem connector described in "Removal of the actuator from the valve body and reassembly" in section 5-3.)
3	Direct-action actuators Remove the diaphragm unit (assembly consisting of the diaphragm plate (#206), diaphragm holder (#209), diaphragm (#214), rod (#220), stud bolt (#210), collar (#212), sealing washer (#205), and set nut (#211)), compressed coil springs (#204) and the spring plate (#206) in this order. Reverse-action actuators Remove the spring plate (#206), compressed coil springs (#204), and the diaphragm unit in this order. When removing the diaphragm unit, pull out the rod along with it. Note: Some models do not have the collar depending on their travel.

● Removing the lower diaphragm case and sealing parts

Step	Procedure
1	Remove the hex nuts (#218) that connect the lower diaphragm case (#217) to the yoke (#228) in order to separate them.
2	Reverse-action actuators Remove the sealing washer (#229), O-ring (#230), rod packing (#231), and dust seal (#207). Direct-action actuators Remove only the dust seal (#207).

● Disassembly of the diaphragm unit

Step	Procedure
1	Loosen and remove the set nut (#211). For the PA5, remove the set nut (#235).
2	Separate each part of the diaphragm unit, remove the coating agents, and clean all of the parts.

6-2 Reassembly of the Actuator

■ Precautions for assembly

- Check that there are no damages to the parts, referring to "Items to check" in "Periodic inspection" of section 4-1. If any damage is found, repair or replace the parts as needed.
- Always use a new sealing washer, dust seal, rod packing, and O-ring.
- Before starting assembly, check the inside of the diaphragm case to make sure there is no foreign matter produced by maintenance. For mounting of the side handwheel on the actuator after assembly of the actuator, refer to「6-7 Mounting the Side Handwheel on the Actuator」.

■ Assembly procedure

Check the size of the actuator and assemble it, referring to Figure 6-1 to Figure 6-4.

● Assembly of the diaphragm unit

Step	Procedure
1	Apply the agent specified below to the parts. The application area is indicated in square brackets. · Stud bolt (#210) [male threads that are engaged with female threads of the rod]: screw lock agent*1 · Stud bolt (#210) [from the male threads that are engaged with the locknut to the male threads at the top of the stud bolt]: sealant*2 · Set nut (#211) [bottom]: sealant*2 · Diaphragm plate (#206) [outer circumference and top surface of the protrusions that contact diaphragm holes]: sealant*2 · Sealing washer (#205) [entire surface]: lubricant*3 · Set nut (PA5 only) (#235) [threads, bottom]: sealant*2 · Yoke (#228) [top surface]: lubricant*3 · Round bushing (#219) [inner surface]: lubricant*3 · Collar (#212) (for reverse action & if the collar is used) [contact surface with the diaphragm plate]: sealant*2 Note: After applying the sealant, immediately tighten the bolts and nuts before the sealant dries.
2	Assemble the diaphragm unit loosely by the following procedure: Mount the stud bolt (#210), rod (#220), diaphragm (#214), diaphragm plate (#206), diaphragm holder (#209), collar (#212), and sealing washer (#205). Align the stopper of the diaphragm plate and the notch in the diaphragm holder as illustrated in Figure 6-6. Then, lightly tighten the set nut (#211) until the parts do not wobble.
3	Mount the lower diaphragm case (#217) on the yoke (#228) temporarily. (do not mount the sealing parts). Set the diaphragm unit in place, and attach the stem connector (#208) to the threads of the rod (#220) temporarily.

Step	Procedure
4	Fix the stem connector (#208) in place utilizing the rotation stopper and then tighten the set nut (#211) of the diaphragm unit to the torque specified in table 6-1. At this time, make sure that the rotational force will not change the positions of the parts illustrated in figure 6-6. [PA5 only] Before tightening the set nut (#211) of the diaphragm unit, tighten two set nuts for the PA5 (#235) to the torque specified in table 6-1.
5	Assembly of the diaphragm plate is now complete. Remove the lower diaphragm case (#217), yoke (#228), and stem connector (#208).

*1 Use LOCTITE No. 648 made by Henkel Corporation.

*2 Use liquid gasket No. 1530 made by ThreeBond Holdings Co., Ltd..

*3 Use Plastilube No. 3 made by Sulflo, Inc.

● Attaching the sealing parts

Step	Procedure
1	Apply a lubricant*2 to the rod packing(#231), O-ring (#230), and dust seal (#207)(for reverse-action actuators) or to the dust seal (#207)(for direct-action actuators), and attach them to the yoke (#228). For each of these parts, apply even pressure over the entire surface.

* Use Plastilube No. 3 made by Sulflo, Inc.

● Mounting the lower diaphragm case

Step	Procedure
1	Check the matching marks and put the lower diaphragm case (#217) on the yoke (#228) in the manner illustrated in Figure 6-7 to Figure 6-13.
2	For reverse-action actuators, apply a lubricant*1 to the entire surface of the sealing washer (#229) and set it in the screw hole of the lower diaphragm case (#217).
3	Apply an anti-seizing agent*2 to the threads and bottom of the hex bolts (#218) and tighten them to the torque specified in Table 6-1.

*1 Use Plastilube No. 3 made by Sulflo, Inc.

*2 Use Never-Seez Pure Nickel Special made by Bostik, Inc.

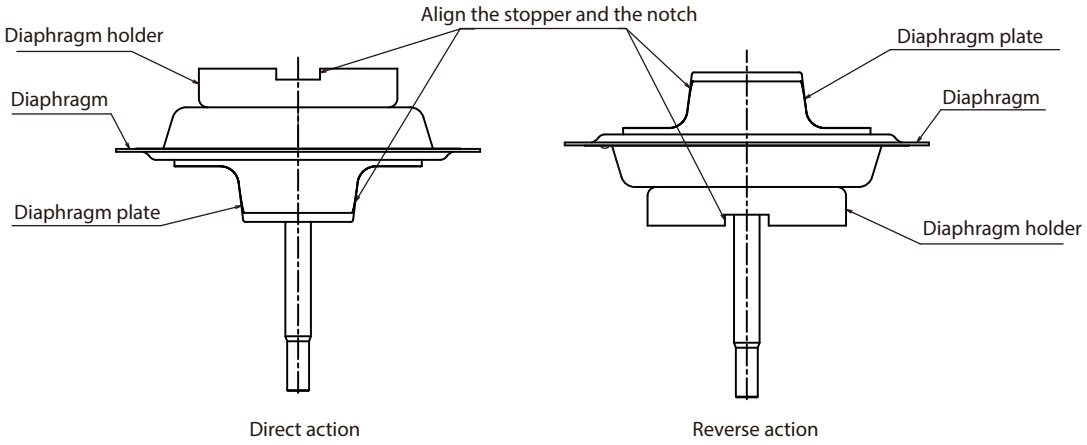


Figure 6-6. Positions of the diaphragm plate and the diaphragm holder

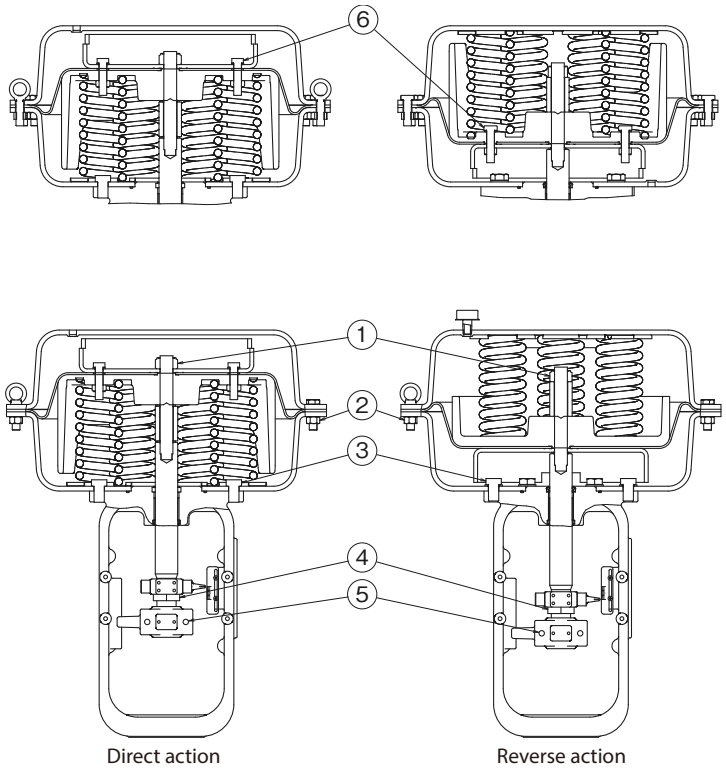


Figure 6-7. Threaded parts to tighten

Table 6-1. Tightening torque for the actuator

Tolerance: ±5 % rdg. Unit: N·m

No. in figure 6-7	Material	PA2		PA3		PA4		PA5	
		Nominal diameter	Torque	Nominal diameter	Torque	Nominal diameter	Torque	Nominal diameter	Torque
1	SUS304	M12	50	M12	50	M20	215	M20	215
2	SUS304	M8	15	M8	15	M10	29	M12	50
3	Carbon steel	M12	50	M12	50	M16	110	M16	110
4	SUS304	M18	75	M18	75	M30	140	M30	140
5	SUS304	M8	15	M8	15	M10	29	M10	29
6	SUS304							M12	50

● Mounting the diaphragm unit and springs

● For direct-action actuators

Step	Procedure
1	Place the spring plate (#206) so that compressed coil springs (#204) can be set in the lower diaphragm case (#217) in the manner illustrated in Figure 6-8 to Figure 6-10. Then, mount compressed coil springs (#204) on the spring plate (#206) so that the upper end of the springs is positioned as illustrated in Figure 6-14 and Figure 6-15.
2	Check that the threads of the rod (#220) of the diaphragm unit are covered with plastic tape or the like.
3	Insert the rod (#220) of the diaphragm unit into the yoke (#228), taking care not to damage the round bushing (#219) and dust seal (#207).
4	Rotate the diaphragm unit so that the stopper of the diaphragm plate (#201) and the air pipe connection port of the lower diaphragm case (#217) are in the positions illustrated in Figure 6-8 to Figure 6-10.

● For reverse-action actuators

Step	Procedure
1	Check that the threads of the rod (#220) of the diaphragm unit are covered with plastic tape or the like.
2	Insert the rod (#220) of the diaphragm unit into the yoke (#228), taking care not to damage the round bushing (#219), dust seal (#207), and rod packing (#231).
3	Rotate the diaphragm unit so that the stopper of the diaphragm plate (#201) and the air pipe connection port of the lower diaphragm case (#217) are in the positions illustrated in Figure 6-11 to Figure 6-13.
4	Mount compressed coil springs (#204) on the diaphragm plate (#201) so that the upper end of the springs is positioned as illustrated in Figure 6-14 and Figure 6-15.
5	Mount the spring plate (#206) on top of the compressed coil springs (#204).

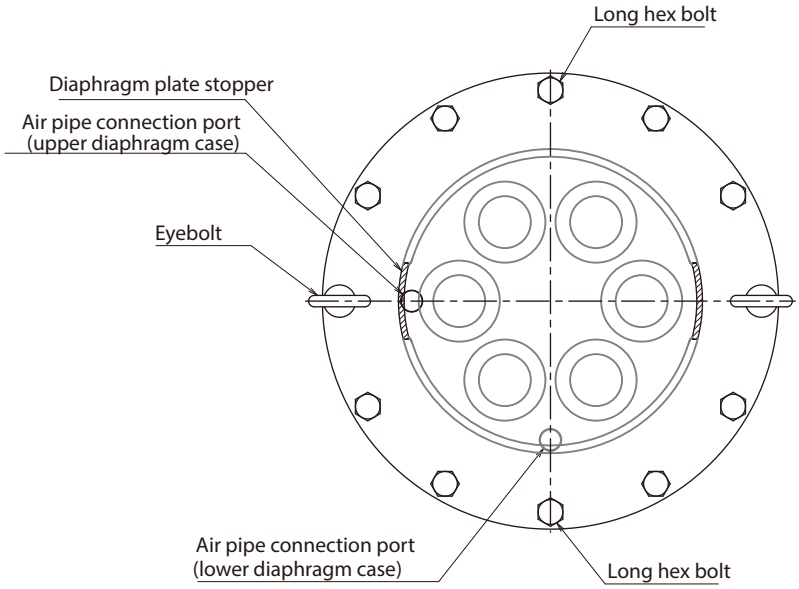


Figure 6-8. Direct-action PA2 actuator parts positions

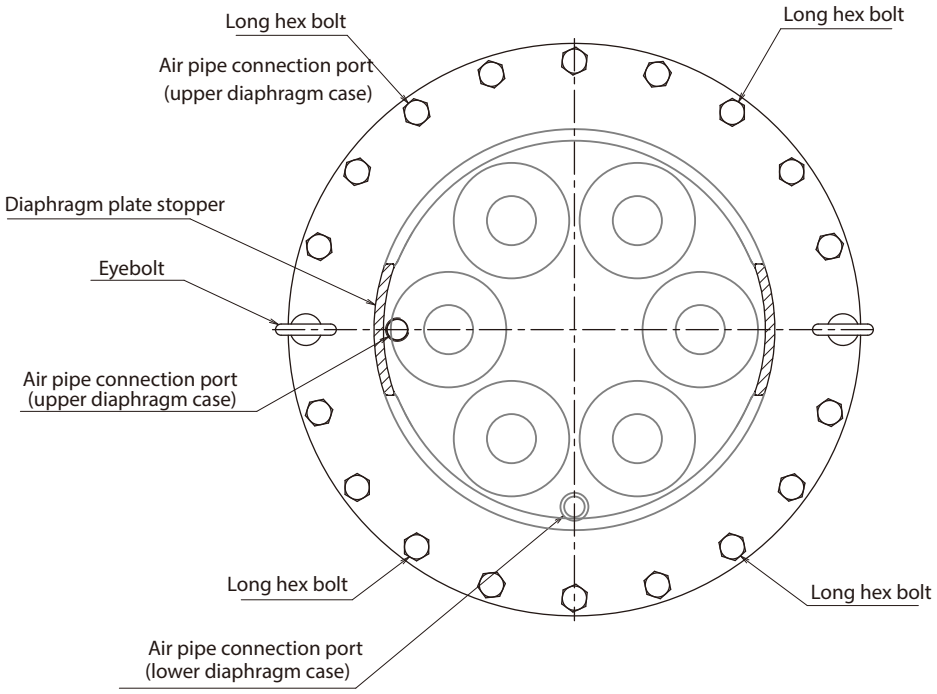


Figure 6-9. Direct-action PA3/PA4 actuator parts positions

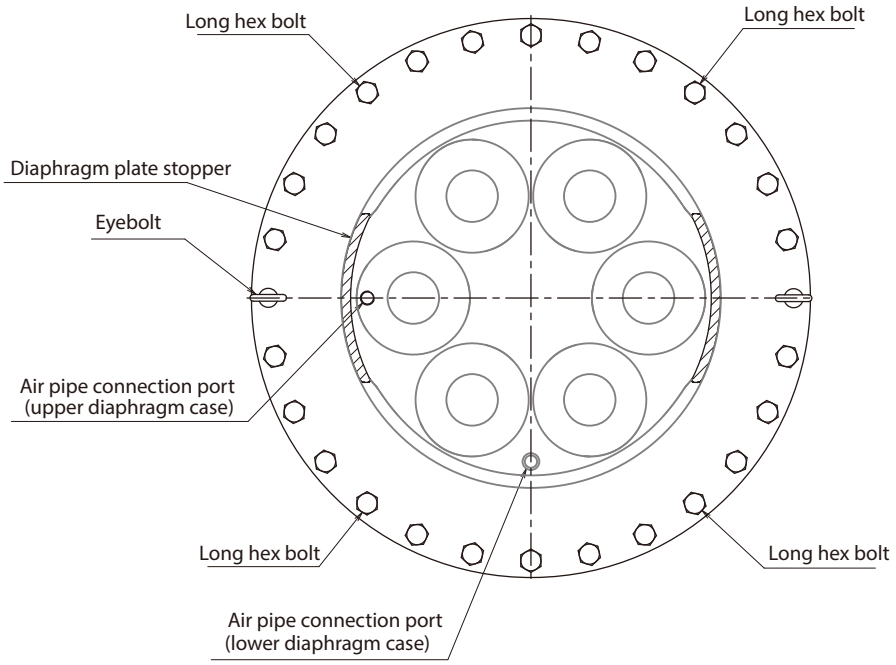


Figure 6-10. Direct-action PA5 actuator parts positions

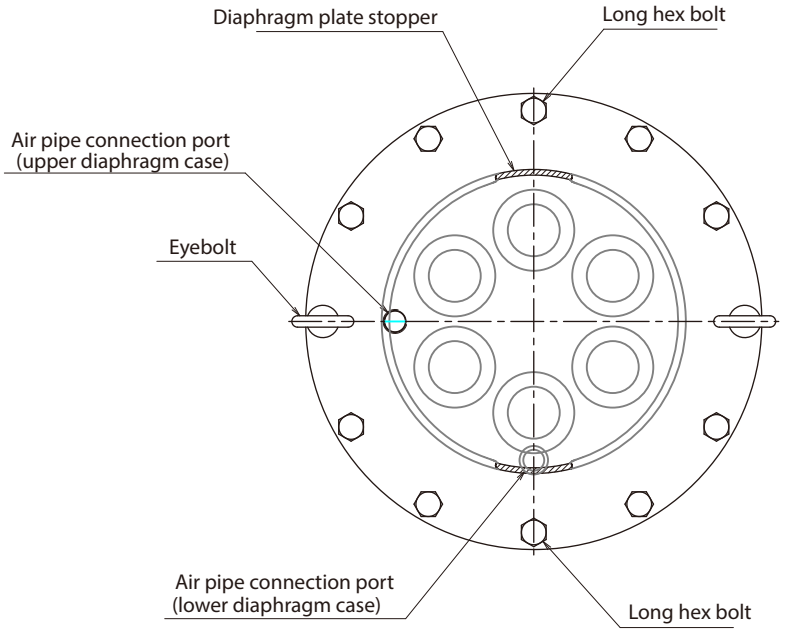


Figure 6-11. Reverse-action PA2 actuator parts positions

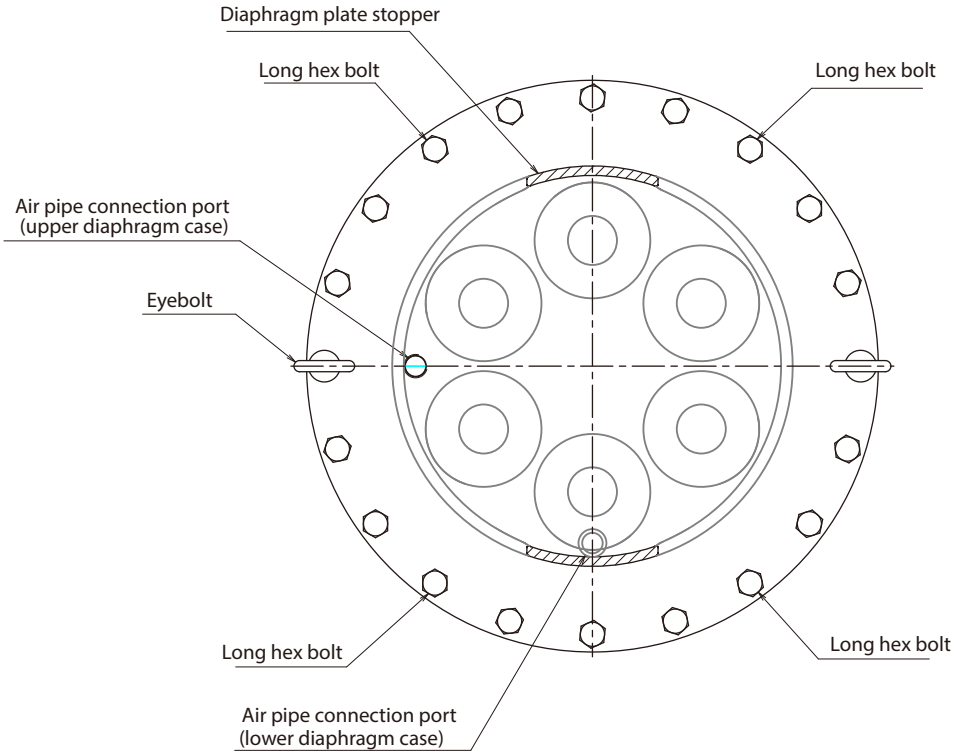


Figure 6-12. Reverse-action PA3/PA4 actuator parts positions

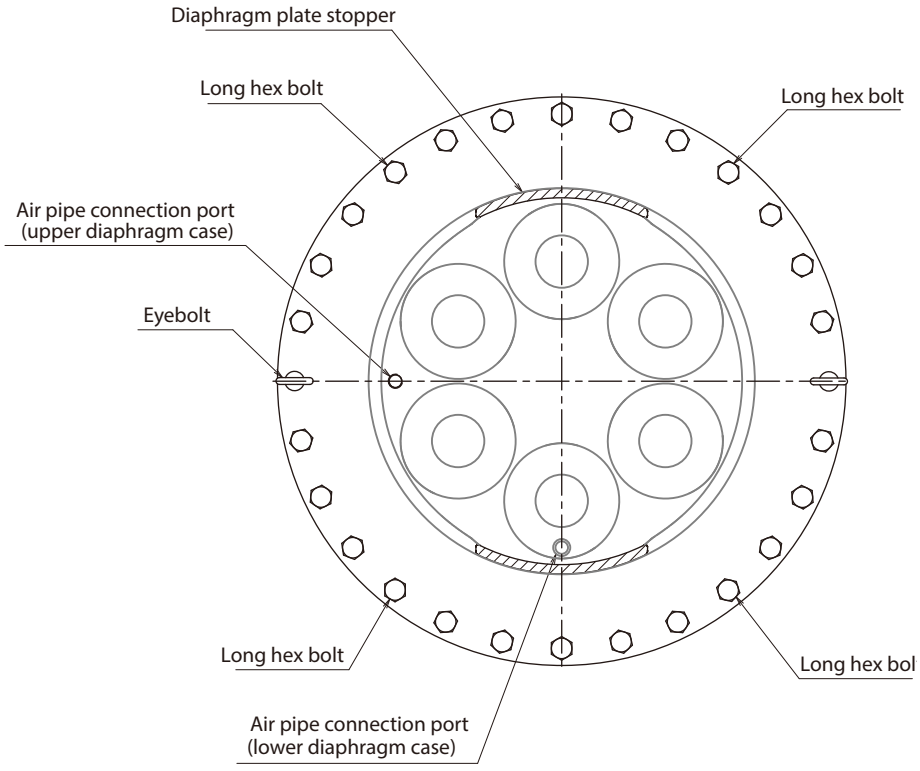
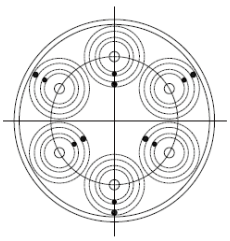
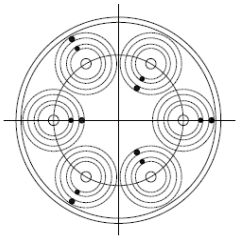
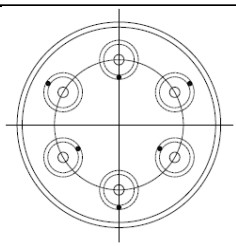
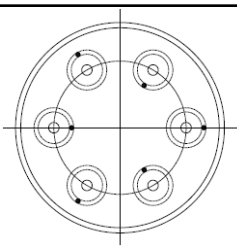
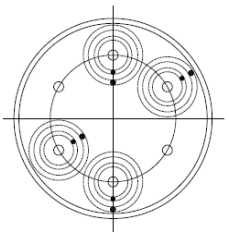
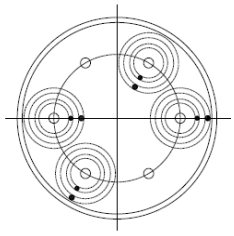
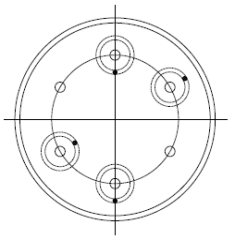
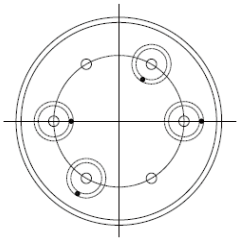
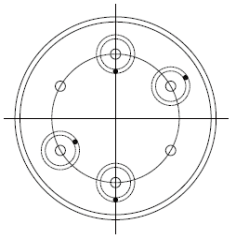
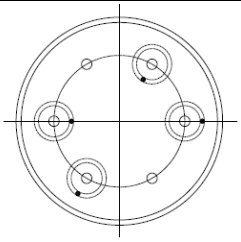
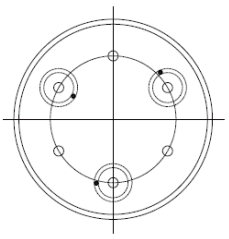
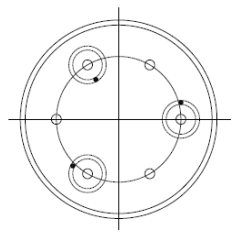
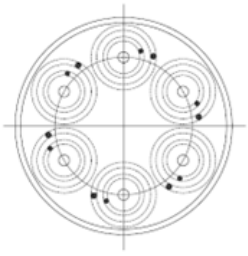
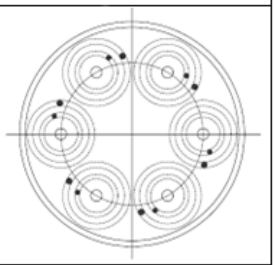
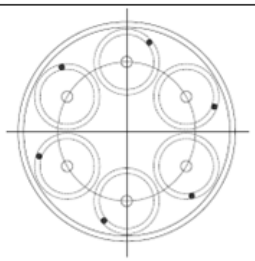
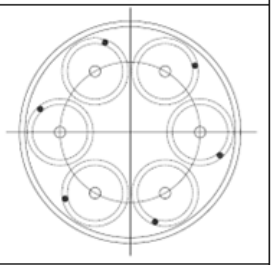
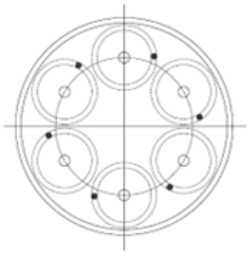
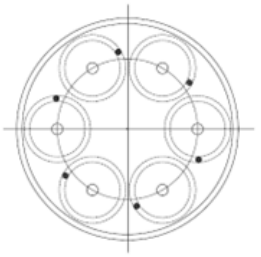
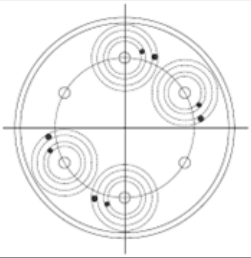
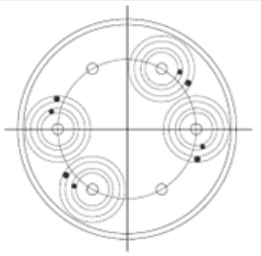
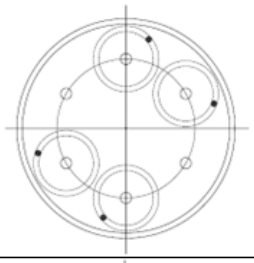
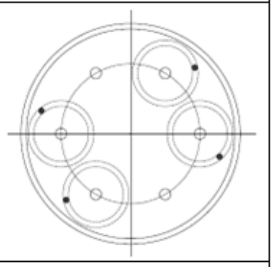
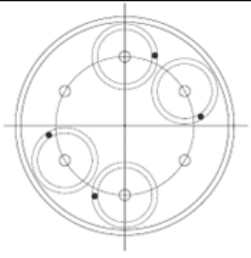
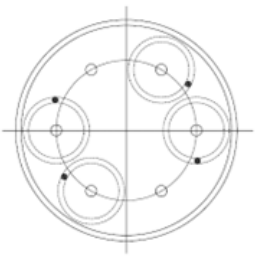
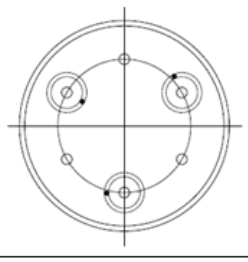
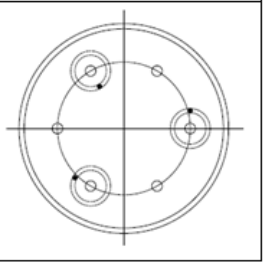


Figure 6-13. Reverse-action PA5 actuator parts positions

Spring range	Number of springs	Travel	Layout of springs (reverse action)	Layout of springs (direct action)
120～280 [kPa]	6	PA3：40 [mm] PA4：40 [mm]		
		PA2：20 [mm] PA3：20 [mm] PA4：20 [mm]		
80～185 [kPa]	4	PA3：40 [mm] PA4：40 [mm]		
		PA2：20 [mm] PA3：20 [mm] PA4：20 [mm]		
20～100 [kPa]	4	PA2：20 [mm]		
	3	PA3：20 [mm] PA4：20 [mm] PA3：40 [mm] PA4：40 [mm]		

Note:● indicates the top end of the compressed coil spring.

Figure 6-14. Compressed coil spring layout (PA2–4)

Spring range	Number of springs	Travel	Layout of springs (reverse action)	Layout of springs (direct action)
120～280 [kPa]	6	75 [mm]		
		40 [mm]		
		20 [mm]		
80～185 [kPa]	4	75 [mm]		
		40 [mm]		
		20 [mm]		
20～100 [kPa]	3	75 [mm] 40 [mm] 20 [mm]		

Note:● indicates the top end of the compressed coil spring.

Figure 6-15. Compressed coil spring layout (PA5)

● Mounting the upper diaphragm case

Important

- **For an actuator that incorporates compressed coil springs, be sure to follow the assembly procedure when attaching bolts and nuts. Otherwise, malfunction may result.**
- **Do not use an impact wrench to tighten hex nuts (#203) for long hex bolts (#216), as it may cause thread galling.**

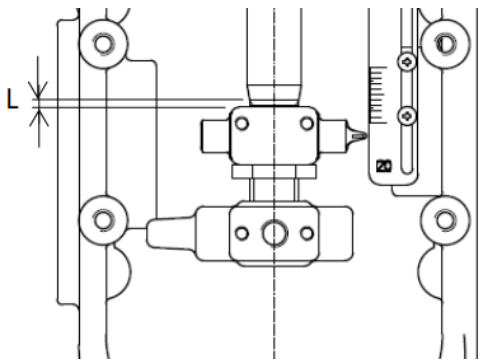
Step	Procedure
1	Set the upper diaphragm case (#213) such that the air pipe connection port is in the position indicated in Figure 6-8 to Figure 6-10 (for direct-action models) or the air vent hole is in the position indicated in Figure 6-11 to Figure 6-13 (for reverse-action models). Check that the matching marks that were made before disassembly are aligned.
2	Apply an anti-seizing agent* to the threads and bottom of bolts.
3	Place the upper diaphragm case (#213) and set bolts so that they are in the positions shown in Figure 6-8 to Figure 6-10 (for direct-action models) or in Figure 6-11 to Figure 6-13 (for reverse-action models). Set the hex nuts (#203) on the long hex bolts, (#216) and then on the hex bolts (#215) and eye bolts (#202). Tighten the nuts evenly in a diagonal pattern to the torque indicated in Table 6-1.
4	For reverse-action actuators, apply sealing tape to the threads of the rain cap (#232) and screw the cap onto the air vent hole of the upper diaphragm case (#213) .

* Use Never-Seez Pure Nikkel Special made by Bostik, Inc., or the equivalent.

● Mounting the pointer

Step	Procedure
1	Apply an anti-seizing agent* to the threads of the rod (#220).
2	Screw the pointer (#222) onto the rod (#220), and adjust the tip of the pointer so it points toward the scale and is set at the height shown in Figure 6-16.
3	Tighten the locknut (#225) to the torque specified in Table 6-1 to secure the pointer (#222) in place.

* Use Never-Seez Pure Nikkel Special made by Bostik, Inc., or the equivalent.



(mm)

Name	Travel	L
PA5	75	13+1/0
PA4-5	40	10+1/0
PA4-5	20	5+1/0
PA3	40	16+1/0
PA3	20	5+1/0
PA2	20	5+1/0

Figure 6-16. Pointer assembly position

● Inspection after reassembly

Step	Procedure
1	Apply air at a pressure of 500 kPa to the diaphragm case through the air pipe connection port of the case. Using soapy water, check the exterior of the diaphragm case (for both direct-action and reverse action models) and the exterior of the rod (reverse-action models only) for air leakage.
2	Check that the stroke is smooth throughout the actuator's travel by varying the air pressure within the supply air pressure range specified for the actuator. Check also that the spring range for the valve opening is the same as the range printed on the nameplate (#226).

6-3 Mounting the Actuator on the Valve Body

■ Precautions for assembly

For a side handwheel–equipped actuator, attach the side handwheel to the actuator first, and then mount the actuator on the valve body.

■ Assembly procedure

● Mounting the yoke on the valve body

Step	Procedure
1	Apply an anti-seizing agent* to the connections of the bonnet, yoke, and the yoke nut.
2	Place the actuator and yoke nut on the valve body. Rotate the actuator so that the matching marks that were placed before disassembly are aligned.
3	Tighten the yoke nut by hand. Then, apply a chisel with a hand guard to the groove of the yoke nut and hammer it in the tightening direction to tighten the nut further.

* Use Never-Seez Pure Nickel Special made by Bostik, Inc.

● Attaching the stem connector

● For direct-action actuators

Step	Procedure
1	Push the valve plug down to set it on the seat.
2	Check the spring range indicated on the nameplate and apply the upper-limit air pressure to the actuator.
3	Further increase the pressure to the supply air pressure and check that the rod moves several mm in response.
4	Reduce the air pressure slightly and set the air pressure to the spring range upper limit again. In this state, temporarily connect the rod and the valve stem with the stem connector.
5	Decrease the air pressure until the valve travel is several percent. In this state, tighten the hex bolts of the stem connector to the torque specified in Table 6-1.

● For reverse-action actuators

Step	Procedure
1	Push the valve plug down to set it on the seat.
2	Check the spring range indicated on the nameplate and apply the lower-limit air pressure to the actuator.
3	Further decrease the air pressure and check that the rod moves several mm in response.
4	Increase the air pressure slightly, and then lower the air pressure to the spring range lower limit. In this state, temporarily connect the rod and the stem with the stem connector.
5	Increase the air pressure until the valve travel is several percent. In this state, tighten the hex bolts of the stem connector to the torque specified in Table 6-1.

● Adjusting the position of the scale

Loosen the truss head screw (#224)on the scale(#223). Then,

- For reverse-action actuators: With air pressure applied at the lower limit of the spring range, adjust the position of the scale so that the tip of the pointer is aligned with the “S” on the scale, and tighten the truss head screw to secure the scale in place.
- For direct-action actuators: With air pressure applied at the upper limit of the spring range, adjust the position of the scale so that the tip off the pointer is aligned with the “S” on the scale, and tighten the truss head screw to secure the scale in place.

● Checking and adjusting travel

Apply the spring range lower/upper limit air pressure to the actuator and check that the pointer moves beyond the rated travel. Also, by applying zero air pressure for direct action models or the supply air pressure for reverse action models, check that the overtravel is 10 % of the rated travel (3 mm when the rated travel is 20 mm) or less. If the rated travel or overtravel is insufficient, remove the stem connector and reattach it after adjusting the air pressure to satisfy the rated travel.

● Attaching the accessories

Attach the accessories in their original position.

● Inspection after reassembly

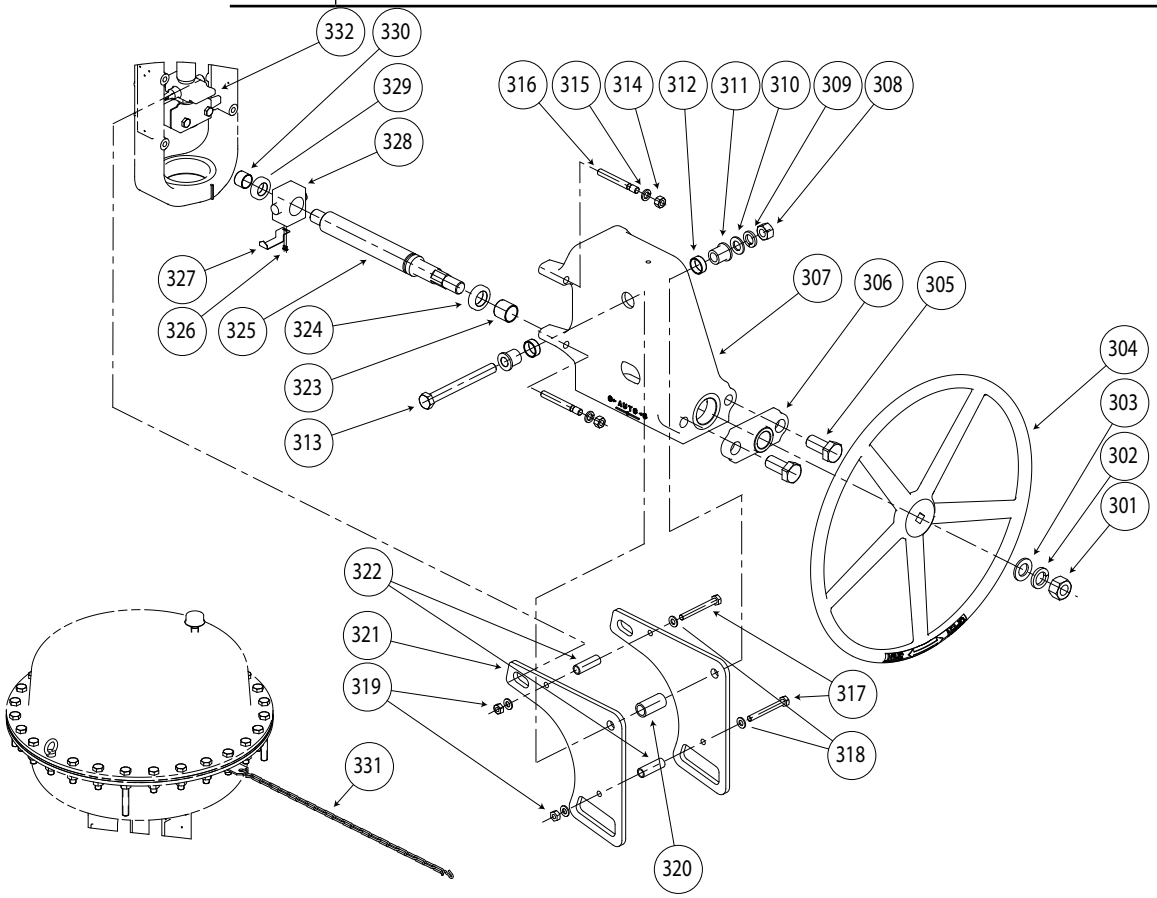
- Send the specified control signals and air pressure to the positioner or the actuator. Check the air pipes and their joints for leakage.
- Change the control signal to check if the valve operates properly in accordance with the signal.
- Check seat leakage to confirm that the performance meets the specification.
- Carry out a pressure shell test for the valve body to confirm that fluid does not leak from between the body and bonnet or from the gland.
- For models with a handwheel, turn the handwheel to check that the valve opens and closes smoothly. Then, turn the handwheel so that the pointer on the lever drive nut indicates AUTO, and check that the valve opens and closes smoothly in accordance with input signals. If there is interference and the valve does not open or close smoothly, adjust the position of the lever drive nut.

6-4 Removing the Side Handwheel from the Actuator

■ Removal procedure

Check the size of the actuator and remove the side handwheel, referring to Figure 6-17.

Step	Procedure
1	Check that the pointer (#327) on the lever drive nut (#328) is in the AUTO range. Remove the locking chain (#331) from the handwheel (#304).
2	Loosen the hex bolts (#317, #313) and hex nuts (#319, #308) that hold the levers (#321). Remove the levers from the boss of the pointer of the actuator (#332).
3	Remove the hex nut (#314) from the stud bolt (#316) that connects the side handwheel and the yoke, and remove the side handwheel from the actuator.



No.	Name	No.	Name	No.	Name	No.	Name
301	Hex nut	309	Spring washer	317	Hex bolt	325	Shaft
302	Spring washer	310	Flat washer	318	Flat washer	326	Round screw
303	Flat washer	311	Bushing	319	Hex nut	327	Pointer
304	Handwheel	312	Round bushing	320	Collar	328	Lever drive nut
305	Hex bolt	313	Hex bolt	321	Lever	329	Small thrust bearing
306	Bearing holder	314	Hex nut	322	Collar	330	Round bushing
307	Side handwheel main unit	315	Spring washer	323	Round bushing	331	Locking chain
308	Hex nut	316	Stud bolt	324	Large thrust bearing	332	Pointer of the actuator

Figure 6-17. Side handwheel structure

6-5 Disassembly of the Side Handwheel

■ Disassembly procedure

Check the size of the actuator and disassemble the side handwheel, referring to Figure 6-17.

Step	Procedure
1	Check that the pointer (#327) on the lever drive nut (#328) is in the AUTO position.
2	Loosen the hex bolts (#317, #313) and hex nuts (#319, #308) that hold the levers (#321). Remove the levers from the bosses of the lever drive nut (#328).
3	Loosen and remove the hex nut (#301) from the handwheel (#304), and remove the handwheel (#304) from the side handwheel main unit (#307).
4	Remove the hex bolts (#305) that hold the bearing holder (#306), and remove the bearing holder (#306) and the large thrust bearing (#324). Separate the shaft (#325) from the lever drive nut (#328) by rotating it, and remove the shaft (#325) and the lever drive nut (#328). Then, remove the small thrust bearing (#329) from the side handwheel main unit (#307).
5	Loosen the hex bolts (#317, #313) and hex nuts (#319, #308) that hold the levers (#321), and remove the levers (#321) from the side handwheel main unit (#307) to complete disassembly.

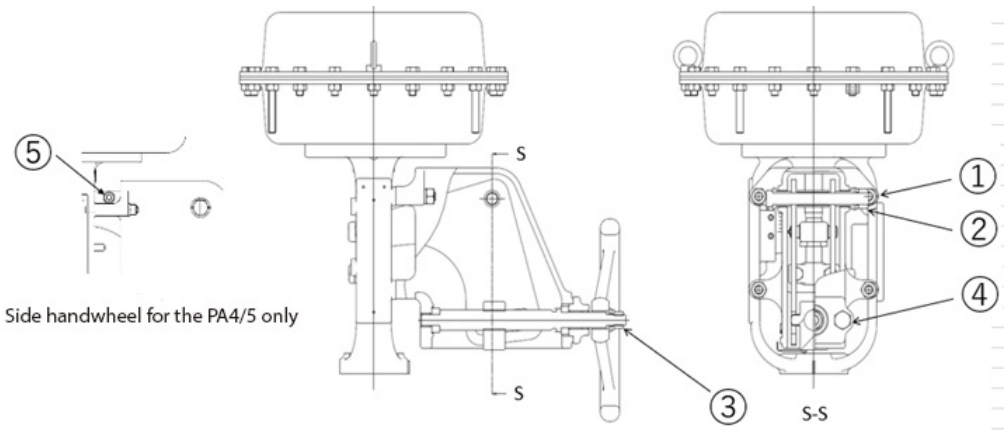


Figure 6-18. Side handwheel screws to tighten

Table 6-2. Tightening torque for the side handwheel

Tolerance: ±5 % rdg. Unit: N·m

No. in figure	Material	PA2		PA3		PA4		PA5	
		Nominal diameter	Torque	Nominal diameter	Torque	Nominal diameter	Torque	Nominal diameter	Torque
1	SUS304	M10	29	M10	29	M12	50	M12	50
2	SUS304	M12	50	M12	50	M18	155	M18	155
3	SUS304	M12	29	M12	29	M24	210	M24	210
4	SUS304	M12	50	M12	50	M24	360	M24	360
5	SUS304					M10	29	M10	29

6-6 Assembly of the Side Handwheel

■ Assembly procedure

Check the size of the actuator and assemble the side handwheel, referring to Figure 6-17.

Step	Procedure
1	Apply the agent specified below to the parts. The application area is indicated in square brackets. (1) Lever (#321) [surface of the holes that contact the boss of the pointer and the boss of the lever drive nut]: anti-seizing agent*2 (2) Shaft (#325) [entire surface of the threads that are engaged with the lever drive nut]: anti-seizing agent*2 (3) Hex nut (#301) [bottom]: anti-seizing agent*2 (4) Hex bolt (#305) [threads, bottom]: anti-seizing agent*2 (5) Stud bolt (#316) [entire surface of the threads that are engaged with hex nut #314]: anti-seizing agent*2 (6) Hex nut (#314) [bottom]: anti-seizing agent*2 (7) Round bushing (#312, #323, #330) (4 pieces, figure 6-16) [inner side]: lubricant*1 (8) Thrust bearing (large and small) (#324, #329) [inner side]: lubricant*1 (9) Hex bolt (#313, #317) [threads, bottom]: anti-seizing agent*2
2	Insert the levers (#321) into the side handwheel main unit (#307). For the PA4 and PA5: Temporarily secure the levers with the hex bolts (#317, #313) and hex nuts (#319, #308).
3	Attach the large thrust bearing (#324) to the shaft (#325) and insert the shaft halfway into the boss of the side handwheel main unit (#307).
4	Screw the lever drive nut (#328) and the small thrust bearing (#329) onto the threads of the shaft (#325). Insert the shaft all the way into the side handwheel main unit (#307), allowing the pointer (#327) attached to the lever drive nut (#328) to stick out of the main unit.
5	Hook the levers (#321) onto the bosses of the lever drive nut (#328) by the holes at the bottom of the levers, and tighten the hex bolt (#313) and hex nut (#308).
6	Mount the bearing holder (#306) on the side handwheel main unit (#307) and secure them by tightening the hex bolts (#305) to the torque shown in Table 6-2.
7	Pass the shaft (#325) through the center of the handwheel (#304) and secure them by tightening the hex nut (#301) to torque shown in Table 6-2 to complete assembly of the side handwheel.

*1 Use Plastilube No. 3 made by Sulflo, 1 Inc.

*2 Use Never-Seez Pure Nickel Special made by Bostik, Inc.

6-7 Mounting the Side Handwheel on the Actuator

■ Assembly procedure

Check the size of the actuator and mount the side handwheel, referring to Figure 6-17.

Step	Procedure
1	Remove the scale from the yoke of the actuator. Turn the handwheel (#304) so that the pointer (#327) on the lever drive nut (#328) indicates AUTO.
2	For the PA4 and PA5: Loosen the hex bolts (#317, #313) and hex nuts (#319, #308) that hold the levers (#321) to increase the distance between the levers (#321).
3	Insert the stud bolt (#316) into the bolt hole in the side handwheel main unit (#307) and tighten the hex nut (#314) to the torque shown in Table 6-2 to mount the side handwheel main unit (#307) on the actuator.
4	Hook the levers (#321) on the bosses on the pointer of the actuator (#332) by the holes near the leading edge of the levers.
5	Tighten the hex bolt (#313) and hex nut (#308) to the torque specified in Table 6-2 to secure the levers (#321) in place. When doing this, set the torque wrench on the bolt. For the PA4 and PA5: There are two pairs of hex bolts (#317) and hex nuts (#319). First, tighten the bolt and nut on the pointer (#332) side. Supply air to the actuator and adjust the position of the levers (#321) so that the other hex bolt (#317) and hex nut (#319) can be tightened through the horizontal hole in the side handwheel main unit (#307). Then, tighten them to the torque specified in Table 6-2. When doing this, set the torque wrench on the bolt. Then, stop supplying air to the actuator and return the levers (#321) to their original positions.
6	Turn the handwheel (#304) to check for smooth operation of the control valve. Then, refer to ● Adjusting the position of the scale (p.6-20) and attach the scale removed in step 1 to the yoke. At this time, apply lubricant* to the threads of the truss head screw (#224) again.
7	Before starting automatic operation of the control valve on the equipment, set the pointer (#327) on the lever drive nut (#328) to the AUTO position and lock the handwheel (#314) with the locking chain (#331).

* Use Plastilube No. 3 made by Sulflo, Inc.

Chapter 7 Maintenance Information

■ Maintenance information

Maintenance parts and our maintenance support are explained below. Please refer to the following when ordering consumables or if there is a problem with the control valve.

■ Ordering

Please contact the azbil Group, having the name of the necessary parts ready.

■ Maintenance service

The azbil Group offers various service programs that provide the advantage of maintenance know-how accumulated over a long period.

We also offer a prompt response to problems in cooperation with our Quality Assurance Department.

Please contact the azbil Group for maintenance of the control valve.

Chapter 8 Disposal

When this product is no longer needed, dispose of it appropriately as industrial waste in accordance with the applicable local regulations. Do not reuse all or a part of this product.
For the materials of this product, refer to the specifications sheet for the valve body and the actuator listed in Appendix A. Packaging materials include wooden frames and cardboard. In some cases, the bags covering the products are made of polyethylene.

Appendix A: Standard Specifications

For the standard specifications of this device, refer to the following specifications sheets.

Valve body: SS2-CVP100-0100
Globe Control Valve Top-Guided Single-Seated Valve
Model AS111 (for normal temp.) / AS211 (for high temp.) / AS311 (for low temp.)
Pressure-Balanced Cage Valve
Model AC111 (for normal temp.) / AC211 (for high temp.) / AC311 (for low temp.)

Actuator: SS2-PAM100-0100
Multi-Spring Diaphragm Actuator Model PA_D/PA_R

Appendix B: Dimensions and Weight

External dimensions and weight of the control valve are indicated in tables B-1 and B-2. Note that dimensions and weight may vary depending on the optional specifications.

Table B-1. Dimensions

Nominal diameter (inches)	Actuator	A (mm)			H (mm)				B (mm)	C by positioner (mm)		D (mm)	E (mm)		
					Bonnet type					AVP300 series					
					Plain		Extension								
					Normal temp. (−17 to +230 °C)		High temp. (230 to 400 °C), low temp. (−45 to −17 °C)								
		class150 PN10,16 JIS10K	class300 PN25,40 JIS16K, 20K,30K	class600 PN63, 100	class150,300 PN10,16, 25,40 JIS10K,16K, 20K,30K	class600 PN63, 100	class150,300 PN10,16, 25,40 JIS10K,16K, 20K,30K	class600 PN63, 100		Pressure regulator integrated	Pressure regulator separated		class150 PN10,16 JIS10K	class300 PN25,40 JIS16K, 20K,30K	class600 PN63, 100
½	PA2	184	190	203	501		626		255	309	217	245	31	32	32
	PA3				542		667		321	309	217	245			
¾	PA2	184	194	206	501		626		255	309	217	245	32	33	33
	PA3				542		667		321	309	217	245			
1	PA2	184	197	210	486		611		255	309	217	245	49	50	50
	PA3				527		652		321	309	217	245			
1½	PA2	222	235	251	511		696		255	309	217	245	69	70	71
	PA3				552		737		321	309	217	245			
	PA4				729		894		411	341	249	360			
	PA5				835		1000		502	341	249	360			
2	PA2	254	267	286	511		696		255	309	217	245	77	78	78
	PA3				552		737		321	309	217	245			
	PA4				729		894		411	341	249	360			
	PA5				835		1000		502	341	249	360			
2½	PA3	276	292	311	622		797		321	309	217	245	88	90	92
	PA4				789		954		411	341	249	360			
	PA5				895		1060		502	341	249	360			
3	PA3	298	317	337	622		797		321	309	217	245	109	110	113
	PA4				789		954		411	341	249	360			
	PA5				895		1060		502	341	249	360			
4	PA3	352	368	394	642		812		321	309	217	245	127	130	134
	PA4				799		974		411	341	249	360			
	PA5				905		1080		502	341	249	360			
6	PA5	451	473	508	980	1085	1230	1250	502	341	249	360	175	195	223
8	PA5	543	568	610	1035	1150	1300	1325	502	341	249	360	200	210	255

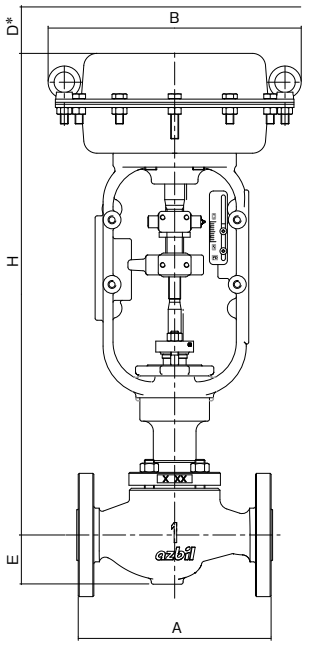


Figure B-1. Face-to-face length and dimensions

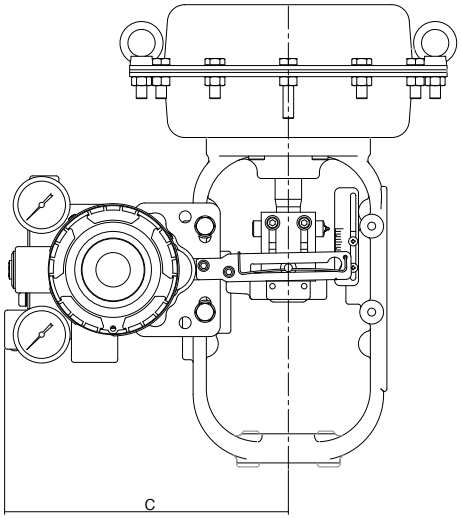


Figure B-2. When AVP300 positioner mounted

* It indicates the required height to the ceiling necessary for disassembly.

Table B-2. Product weight (excluding side handwheel)

Weight tolerance: +20/0 %

Nominal diameter (inches)	Actuator	Weight (kg)						Max. weight for lifting with eyebolts (kg)
		class150 PN10,16 JIS10K		class300 PN25,40 JIS16K,20K,30K		class600 PN63,100		
		Plain	Extension	Plain	Extension	Plain	Extension	
		Normal temp. (−17 to +230 °C)	High temp. (230 to 400 °C), low temp. (−45 to −17 °C)	Normal temp. (−17 to +230 °C)	High temp. (230 to 400 °C), low temp. (−45 to −17 °C)	Normal temp. (−17 to +230 °C)	High temp. (230 to 400 °C), low temp. (−45 to −17 °C)	
½	PA2	17	18	18	19	19	20	80
	PA3	27	28	28	29	29	30	80
¾	PA2	18	18	19	20	20	20	80
	PA3	28	28	29	30	30	30	80
1	PA2	18	19	20	20	21	21	80
	PA3	28	29	30	30	31	31	80
1½	PA2	30	32	33	35	42	44	80
	PA3	40	42	43	45	52	54	80
	PA4	69	71	72	74	81	83	150
	PA5	103	105	106	108	115	117	220
2	PA2	33	35	36	37	38	40	80
	PA3	43	45	46	47	48	50	80
	PA4	72	74	75	77	77	79	150
	PA5	106	108	109	111	111	113	220
2½	PA3	63	66	64	66	70	72	80
	PA4	94	98	94	97	100	104	150
	PA5	128	132	128	131	134	138	220
3	PA3	66	69	70	72	77	80	80
	PA4	98	101	100	102	108	111	150
	PA5	132	135	134	136	142	145	220
4	PA3	91	93	98	100	116	119	80
	PA4	124	126	129	132	148	152	150
	PA5	158	160	163	166	182	186	220
6	PA5	232	235	255	258	320	323	220
8	PA5	332	335	371	375	445	449	220

Table B-3. Product weight (including side handwheel)

Weight tolerance: +20/0 %

Nominal diameter (inches)	Actuator	Weight (kg)						Max. weight for lifting with eyebolts (kg)
		class150 PN10,16 JIS10K		class300 PN25,40 JIS16K,20K,30K		class600 PN63,100		
		Plain	Extension	Plain	Extension	Plain	Extension	
		Normal temp. (–17 to +230 ℃)	High temp. (230 to 400 ℃), low temp. (–45 to –17 ℃)	Normal temp. (–17 to +230 ℃)	High temp. (230 to 400 ℃), low temp. (–45 to –17 ℃)	Normal temp. (–17 to +230 ℃)	High temp. (230 to 400 ℃), low temp. (–45 to –17 ℃)	
½	PA2	27	28	28	29	29	30	80
	PA3	37	38	38	39	39	40	80
¾	PA2	28	28	29	30	30	30	80
	PA3	38	38	39	40	40	40	80
1	PA2	28	29	30	30	31	31	80
	PA3	38	39	40	40	41	41	80
1½	PA2	40	42	43	45	52	54	80
	PA3	50	52	53	55	62	64	80
	PA4	113	115	116	118	125	127	150
	PA5	147	149	150	152	159	161	220
2	PA2	43	45	46	47	48	50	80
	PA3	53	55	56	57	58	60	80
	PA4	116	118	119	121	121	123	150
	PA5	150	152	153	155	155	157	220
2½	PA3	73	76	74	76	80	82	80
	PA4	138	142	138	141	144	148	150
	PA5	172	176	172	175	178	182	220
3	PA3	76	79	80	82	87	90	80
	PA4	142	145	144	146	152	155	150
	PA5	176	179	178	180	186	189	220
4	PA3	101	103	108	110	126	129	80
	PA4	168	170	173	176	192	196	150
	PA5	202	204	207	210	226	230	220
6	PA5	276	279	299	302	364	367	220
8	PA5	376	379	415	419	489	493	220

Dimensions and weight will change if a handwheel is mounted. In the case of a standard assembly, the side handwheel will be located in the back of the actuator (at the 180° position when viewing from the positioner-mounted side).

Table B-4. Handwheel dimensions

Handwheel type	Actuator	Dimensions (mm)		Maximum operating force of the handwheel (N)	Weight (kg)
		φF	K		
Side handwheel	PA2D/R	217	288	245	10
	PA3D/R	217		340	
	PA4D/R	575	476	380	44
	PA5D/R	575		555	

Note: The weight is the weight of the handwheel.

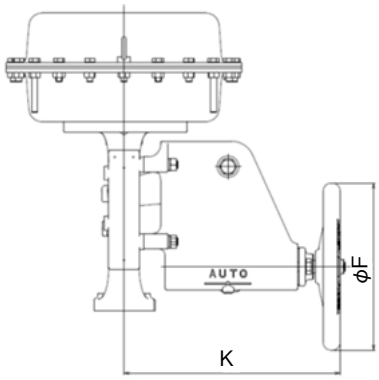


Figure B-3. Side handwheel–equipped actuator

Appendix C: Main Parts to be Replaced

Parts of this control valve can be used for a long period of time, but the following parts should be replaced at every periodic inspection.
Also, be sure to fully understand the structure before carrying out replacement work.

■ Valve body

- Gland packing (replace whenever disassembling)
- Gaskets (replace whenever disassembling)
- Sealing ring
- Scraper ring
- Carbon ring
- Expander ring
- Belleville springs

■ Actuator

- Diaphragm: Every five years
- Round bushing: Replace if damaged.
- Sealing washer: Every five years (and whenever disassembling)
- Dust seal: Every five years (and whenever disassembling)
- Rod seal: Every five years (and whenever disassembling)
- O-ring: Every five years (and whenever disassembling)

For parts replacement, please contact us.

Terms and Conditions

We would like to express our appreciation for your purchase and use of Azbil Corporation's products.

You are required to acknowledge and agree upon the following terms and conditions for your purchase of Azbil Corporation's products (system products, field instruments, control valves, and control products), unless otherwise stated in any separate document, including, without limitation, estimation sheets, written agreements, catalogs, specifications and instruction manuals.

1. Warranty period and warranty scope

1.1 Warranty period

Azbil Corporation's products shall be warranted for one (1) year from the date of your purchase of the said products or the delivery of the said products to a place designated by you.

1.2 Warranty scope

In the event that Azbil Corporation's product has any failure attributable to azbil during the aforementioned warranty period, Azbil Corporation shall, without charge, deliver a replacement for the said product to the place where you purchased, or repair the said product and deliver it to the aforementioned place. Notwithstanding the foregoing, any failure falling under one of the following shall not be covered under this warranty:

(1) Failure caused by your improper use of azbil product (noncompliance with conditions, environment of use, precautions, etc. set forth in catalogs, specifications, instruction manuals, etc.);
(2) Failure caused for other reasons than Azbil Corporation's product;
(3) Failure caused by any modification or repair made by any person other than Azbil Corporation or Azbil Corporation's subcontractors;
(4) Failure caused by your use of Azbil Corporation's product in a manner not conforming to the intended usage of that product;
(5) Failure that the state-of-the-art at the time of Azbil Corporation's shipment did not allow Azbil Corporation to predict; or
(6) Failure that arose from any reason not attributable to Azbil Corporation, including, without limitation, acts of God, disasters, and actions taken by a third party.

Please note that the term "warranty" as used herein refers to equipment-only-warranty, and Azbil Corporation shall not be liable for any damages, including direct, indirect, special, incidental or consequential damages in connection with or arising out of Azbil Corporation's products.

2. Ascertainment of suitability

You are required to ascertain the suitability of Azbil Corporation's product in case of your use of the same with your machinery, equipment, etc. (hereinafter referred to as "Equipment") on your own responsibility, taking the following matters into consideration:

(1) Regulations and standards or laws that your Equipment is to comply with.
(2) Examples of application described in any documents provided by Azbil Corporation are for your reference purpose only, and you are required to check the functions and safety of your Equipment prior to your use.
(3) Measures to be taken to secure the required level of the reliability and safety of your Equipment in your use
Although azbil is constantly making efforts to improve the quality and reliability of Azbil Corporation's products, there exists a possibility that parts and machinery may break down. You are required to provide your Equipment with safety design such as fool-proof design,*1 and fail-safe design*2 (anti-flame propagation design, etc.), whereby preventing any occurrence of physical injuries, fires, significant damage, and so forth. Furthermore, fault avoidance,*3 fault tolerance,*4 or the like should be incorporated so that the said Equipment can satisfy the level of reliability and safety required for your use.

*1. A design that is safe even if the user makes an error.
*2. A design that is safe even if the device fails.
*3. Avoidance of device failure by using highly reliable components, etc.
*4. The use of redundancy.

3. Precautions and restrictions on application

3.1 Restrictions on application

Please follow the table below for use in nuclear power or radiation-related equipment.

	Nuclear power quality*5 required	Nuclear power quality*5 not required
Within a radiation controlled area*6	Cannot be used (except for limit switches for nuclear power*7)	Cannot be used (except for limit switches for nuclear power*7)
Outside a radiation controlled area*6	Cannot be used (except for limit switches for nuclear power*7)	Can be used

*5. Nuclear power quality: compliance with JEAG 4121 required
*6. Radiation controlled area: an area governed by the requirements of article 3 of "Rules on the Prevention of Harm from Ionizing Radiation," article 2 2 4 of "Regulations on Installation and Operation of Nuclear Reactors for Practical Power Generation," article 4 of "Determining the Quantity, etc., of Radiation-Emitting Isotopes,"etc.
*7. Limit switch for nuclear power: a limit switch designed, manufactured and sold according to IEEE 382 and JEAG 4121.

Any Azbil Corporation's products shall not be used for/with medical equipment.

The products are for industrial use. Do not allow general consumers to install or use any Azbil Corporation's product. However, azbil products can be incorporated into products used by general consumers. If you intend to use a product for that purpose, please contact one of our sales representatives.

3.2 Precautions on application

you are required to conduct a consultation with our sales representative and understand detail specifications, cautions for operation, and so forth by reference to catalogs, specifications, instruction manual, etc. in case that you intend to use azbil product for any purposes specified in (1) through (6) below. Moreover, you are required to provide your Equipment with fool-proof design, fail-safe design, anti-flame propagation design, fault avoidance, fault tolerance, and other kinds of protection/safety circuit design on your own responsibility to ensure reliability and safety, whereby preventing problems caused by failure or nonconformity.

(1) For use under such conditions or in such environments as not stated in technical documents, including catalogs, specification, and instruction manuals
(2) For use of specific purposes, such as:
    * Nuclear energy/radiation related facilities
      [When used outside a radiation controlled area and where nuclear power quality is not required]
      [When the limit switch for nuclear power is used]
    * Machinery or equipment for space/sea bottom
    * Transportation equipment
      [Railway, aircraft, vessels, vehicle equipment, etc.]
    * Antidisaster/crime-prevention equipment
    * Burning appliances
    * Electrothermal equipment
    * Amusement facilities
    * Facilities/applications associated directly with billing
(3) Supply systems such as electricity/gas/water supply systems, large-scale communication systems, and traffic/air traffic control systems requiring high reliability
(4) Facilities that are to comply with regulations of governmental/public agencies or specific industries
(5) Machinery or equipment that may affect human lives, human bodies or properties
(6) Other machinery or equipment equivalent to those set forth in items (1) to (5) above which require high reliability and safety

4. Precautions against long-term use

Use of Azbil Corporation's products, including switches, which contain electronic components, over a prolonged period may degrade insulation or increase contact-resistance and may result in heat generation or any other similar problem causing such product or switch to develop safety hazards such as smoking, ignition, and electrification. Although acceleration of the above situation varies depending on the conditions or environment of use of the products, you are required not to use any Azbil Corporation's products for a period exceeding ten (10) years unless otherwise stated in specifications or instruction manuals.

5. Recommendation for renewal

Mechanical components, such as relays and switches, used for Azbil Corporation's products will reach the end of their life due to wear by repetitious open/close operations.

In addition, electronic components such as electrolytic capacitors will reach the end of their life due to aged deterioration based on the conditions or environment in which such electronic components are used. Although acceleration of the above situation varies depending on the conditions or environment of use, the number of open/close operations of relays, etc. as prescribed in specifications or instruction manuals, or depending on the design margin of your machine or equipment, you are required to renew any Azbil Corporation's products every 5 to 10 years unless otherwise specified in specifications or instruction manuals. System products, field instruments (sensors such as pressure/flow/level sensors, regulating valves, etc.) will reach the end of their life due to aged deterioration of parts. For those parts that will reach the end of their life due to aged deterioration, recommended replacement cycles are prescribed. You are required to replace parts based on such recommended replacement cycles.

6. Other precautions

Prior to your use of Azbil Corporation's products, you are required to understand and comply with specifications (e.g., conditions and environment of use), precautions, warnings/cautions/notices as set forth in the technical documents prepared for individual Azbil Corporation's products, such as catalogs, specifications, and instruction manuals to ensure the quality, reliability, and safety of those products.

7. Changes to specifications

Please note that the descriptions contained in any documents provided by azbil are subject to change without notice for improvement or for any other reason. For inquires or information on specifications as you may need to check, please contact our branch offices or sales offices, or your local sales agents.

8. Discontinuance of the supply of products/parts

Please note that the production of any Azbil Corporation's product may be discontinued without notice. After manufacturing is discontinued, we may not be able to provide replacement products even within the warranty period.

For repairable products, we will, in principle, undertake repairs for five (5) years after the discontinuance of those products. In some cases, however, we cannot undertake such repairs for reasons, such as the absence of repair parts. For system products, field instruments, we may not be able to undertake parts replacement for similar reasons.

9. Scope of services

Prices of Azbil Corporation's products do not include any charges for services such as engineer dispatch service. Accordingly, a separate fee will be charged in any of the following cases:

(1) Installation, adjustment, guidance, and attendance at a test run
(2) Maintenance, inspection, adjustment, and repair
(3) Technical guidance and technical education
(4) Special test or special inspection of a product under the conditions specified by you

Please note that we cannot provide any services as set forth above in a nuclear energy controlled area (radiation controlled area) or at a place where the level of exposure to radiation is equivalent to that in a nuclear energy controlled area.

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