



# Operation Manual

PRODUCT NAME

*Rotary Table*

MODEL / Series / Product Number

MSQ

**SMC Corporation**

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# Safety Instructions

These safety instructions are intended to prevent hazardous situations and/or equipment damage. These instructions indicate the level of potential hazard with the labels of "Caution," "Warning" or "Danger." They are all important notes for safety and must be followed in addition to International Standards (ISO/IEC)<sup>\*1)</sup>, and other safety regulations.

\*1) ISO 4414: Pneumatic fluid power -- General rules relating to systems.

ISO 4413: Hydraulic fluid power -- General rules relating to systems.

IEC 60204-1: Safety of machinery -- Electrical equipment of machines .(Part 1: General requirements)

ISO 10218-1992: Manipulating industrial robots -Safety.

etc.



## Caution

**Caution** indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.



## Warning

**Warning** indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.



## Danger

**Danger** indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.



## Warning

### 1. The compatibility of the product is the responsibility of the person who designs the equipment or decides its specifications.

Since the product specified here is used under various operating conditions, its compatibility with specific equipment must be decided by the person who designs the equipment or decides its specifications based on necessary analysis and test results.

The expected performance and safety assurance of the equipment will be the responsibility of the person who has determined its compatibility with the product.

This person should also continuously review all specifications of the product referring to its latest catalog information, with a view to giving due consideration to any possibility of equipment failure when configuring the equipment.

### 2. Only personnel with appropriate training should operate machinery and equipment.

The product specified here may become unsafe if handled incorrectly.

The assembly, operation and maintenance of machines or equipment including our products must be performed by an operator who is appropriately trained and experienced.

### 3. Do not service or attempt to remove product and machinery/equipment until safety is confirmed.

1. The inspection and maintenance of machinery/equipment should only be performed after measures to prevent falling or runaway of the driven objects have been confirmed.

2. When the product is to be removed, confirm that the safety measures as mentioned above are implemented and the power from any appropriate source is cut, and read and understand the specific product precautions of all relevant products carefully.

3. Before machinery/equipment is restarted, take measures to prevent unexpected operation and malfunction.

### 4. Contact SMC beforehand and take special consideration of safety measures if the product is to be used in any of the following conditions.

1. Conditions and environments outside of the given specifications, or use outdoors or in a place exposed to direct sunlight.

2. Installation on equipment in conjunction with atomic energy, railways, air navigation, space, shipping, vehicles, military, medical treatment, combustion and recreation, or equipment in contact with food and beverages, emergency stop circuits, clutch and brake circuits in press applications, safety equipment or other applications unsuitable for the standard specifications described in the product catalog.

3. An application which could have negative effects on people, property, or animals requiring special safety analysis.

4. Use in an interlock circuit, which requires the provision of double interlock for possible failure by using a mechanical protective function, and periodical checks to confirm proper operation.



# Safety Instructions

## Caution

### **1. The product is provided for use in manufacturing industries.**

The product herein described is basically provided for peaceful use in manufacturing industries.

If considering using the product in other industries, consult SMC beforehand and exchange specifications or a contract if necessary.

If anything is unclear, contact your nearest sales branch.

## **Limited warranty and Disclaimer/Compliance Requirements**

The product used is subject to the following “Limited warranty and Disclaimer” and “Compliance Requirements”.

Read and accept them before using the product.

### **Limited warranty and Disclaimer**

#### **1. The warranty period of the product is 1 year in service or 1.5 years after the product is delivered, whichever is first.**

Also, the product may have specified durability, running distance or replacement parts. Please consult your nearest sales branch.

#### **2. For any failure or damage reported within the warranty period which is clearly our responsibility, a replacement product or necessary parts will be provided.**

This limited warranty applies only to our product independently, and not to any other damage incurred due to the failure of the product.

#### **3. Prior to using SMC products, please read and understand the warranty terms and disclaimers noted in the specified catalog for the particular products.**

### **Compliance Requirements**

#### **1. The use of SMC products with production equipment for the manufacture of weapons of mass destruction (WMD) or any other weapon is strictly prohibited.**

#### **2. The exports of SMC products or technology from one country to another are governed by the relevant security laws and regulations of the countries involved in the transaction. Prior to the shipment of a SMC product to another country, assure that all local rules governing that export are known and followed.**

## Caution

### **SMC products are not intended for use as instruments for legal metrology.**

Measurement instruments that SMC manufactures or sells have not been qualified by type approval tests relevant to the metrology (measurement) laws of each country.

Therefore, SMC products cannot be used for business or certification ordained by the metrology (measurement) laws of each country.

# **Warning**

### **1. Confirm the specifications.**

Products represented in this catalog are designed only for use in compressed air systems.

Do not operate at pressures or temperatures, etc., beyond the range of specifications, as this can cause damage or malfunction. (Refer to the specifications.)

Please contact SMC when using a fluid other than compressed air.

We do not guarantee against any damage if the product is used outside of the specification range.

### **2. If the operation involves load fluctuations, ascending/descending movements, or changes in friction resistance, make sure to provide safety measures.**

Operating speed will increase, and bodily injury may occur, or damage to the machinery itself may occur.

### **3. If there is a chance that the product will pose a hazard to humans, install a protective cover.**

If the moving portion of the product will pose a hazard to humans or will damage machinery or equipment, provide a construction that prevents direct contact with those areas.

### **4. Be certain that the secured portions will not loosen.**

Be certain to adopt a reliable connecting method if the rotary table is used very frequently or if it is used in a location that is exposed to a large amount of vibrations.

### **5. There may be cases in which a speed reduction circuit or a shock absorber is required.**

If the driven object moves at high speeds or is heavy, it will be unfeasible for only the rotary table's cushion to absorb the shock. Therefore, provide a speed-reduction circuit to reduce the rotary table's speed before the thrust is applied to the cushion, or an external shock absorber to dampen the shock.

If these countermeasures are taken, make sure to take the rigidity of the mechanical equipment into consideration.

### **6. Consider the possibility of a reduction in the circuit air pressure caused by a power failure.**

When a rotary table is used as clamping mechanism, there is a danger of workpiece dropping if there is a decrease in clamping force, due to a drop in circuit pressure caused by a power failure. Therefore, safety equipment should be installed to prevent damage to machinery and bodily injury.

### **7. Consider the possibility of power source related malfunctions that could occur.**

For the machinery equipment that rely on power sources such as compressed air, electricity, or hydraulic pressure, adopt countermeasure to prevent the equipment from causing a hazard to humans or damage to the machinery and equipment in the event of malfunction.

### **8. If a speed controller is provided in the exhaust restrictor, implement a safety design taking the residual pressure into consideration.**

If air pressure is applied to the air supply side without residual pressure in the exhaust side, the rotary table will operate at abnormally high speeds, which could pose a hazard to humans and damage the machinery and equipment.

### **9. Consider the behavior of the rotary table in the event of an emergency stop.**

Devise a safe system so that if a person engages the emergency stop, or if a safety device is tripped during a system malfunction such as a power failure, the movement of the rotary table will not cause a hazard to humans or damage the equipment.

### **10. Consider the action of the rotary table when restarting after an emergency stop.**

Devise a safe design so that the restarting of the rotary table will not pose a hazard to humans or damage the equipment. Install manually controlled equipment for safety when the rotary table has to be reset to the starting position.

### **11. Do not use the product as a shock absorber.**

If an abnormal pressure or air leakage occurs, the rotary table's speed reduction capability could become severely affected, which could pose a hazard to humans and damage the machinery and equipment.

**12. Select a speed within the product's allowable energy value.**

If the product's kinetic energy of the load exceeds the allowable value, it could damage the product, and cause a hazard to humans and damage the machinery and equipment.

**13. Provide a shock absorber if the kinetic energy that is applied to the product exceeds the allowable value.**

If the product's kinetic energy exceeds the allowable value, it could damage the product, and cause a hazard to humans and damage the machinery or equipment.

**14. Do not stop or hold the product at midpoint by keeping air pressure in the product. (Air balancers etc.)**

For a product lacking an external stopping mechanism, if the directional control valve is closed to keep the air pressure in the product, in an attempt to stop the product at midpoint, it might not be possible to maintain that stopped position due to an air leakage. As a result, it could pose a hazard to humans and cause damage to machinery and/or equipment.

**15. Do not use two or more rotary tables with the aim of synchronized movement.**

One of the rotary tables may bear the load of operation, making synchronized movement impossible, and possibly leading to deformation of the equipment.

**16. Do not use in a location where adverse effect could be occurred by the oozing of the lubricant to the exterior.**

The lubricant coating the interior of the product may leak to the outside of the product from connecting parts of the rotary body, cover, etc.

**17. Do not disassemble the product or make any modifications, including additional machining.**

This may cause human injury and/or an accident.

**18. Refer to the Auto Switches Precautions for using with an auto switch.**

## **Caution**

**1. Do not use below the speed adjustment range specified for the product.**

If the product is used below the specified speed adjustment range, it could cause the product to stick, slip, or the movement to stop.

**2. Do not apply an external torque to the product that exceeds the rated output.**

If an external force that exceeds the product's rated output is applied to the product, it could damage the product.

**3. The holding torque of the rotating end of the double piston type**

If the internal piston of a double piston product comes in contact with the angle adjustment screen or the cover and stops, the holding torque at the rotating end is one half of the actual output.

**4. If it is necessary to provide repeatability of the rotation angle, directly stop the load externally.**

Even with a product that is equipped with an angle adjuster, there are times when the initial rotation angle could change.

**5. Do not use under hydraulic pressure.**

The product will be damaged if it is used by applying hydraulic pressure.

**6. There is a possibility of backlash being generated when stopping the double piston style in the middle with a valve of the closed center type.**

**7. Do not use in a places where there are many temperature fluctuations.**

**When using in lower temperature applications, use caution so that frost does not occur inside the cylinder or the piston rod.**

Operation may be unstable.

**8. Adjust the speed control in the environment in which it will be used in.**

Speed adjustment may be changed if the environment is different.

## Mounting

# **Warning**

### **1. Operation manual**

Install the product and operate it only after reading the operation manual carefully and understanding its contents. Also, keep the manual in a location where it can be referred to as necessary.

### **2. Ensure sufficient space for maintenance activities.**

When installing the products, allow access for maintenance.

### **3. Tighten threads with the proper tightening torque.**

When installing the products, follow the listed torque specifications.

### **4. Before adjusting the angle by supplying air pressure, take appropriate measures to prevent the equipment from rotating unnecessarily.**

When an adjustment is performed under air pressure, the equipment could rotate and fall during the adjustment, depending on the mounted posture of the equipment. As a result, it could pose a hazard to humans and damage the machinery and equipment.

### **5. Do not loosen the angle adjustment screw beyond the allowable adjustment range.**

The angle adjustment screw could fall out if it is loosened beyond its allowable adjustment range, which could pose a hazard to humans and damage the machinery and equipment.

### **6. Do not place a magnetic object near the product.**

The auto switch is a magnetic sensing type. If a magnetic object is placed close to it, the rotary table could operate suddenly, which could pose a hazard to humans and damage the machinery and equipment.

### **7. Do not perform additional machining to the product.**

Additional machining to the product can result in insufficient strength and cause damage to the product. This can lead to possible human injury and damage to the surrounding equipment.

### **8. Do not enlarge the fixed throttle by modifying the pipe connectors.**

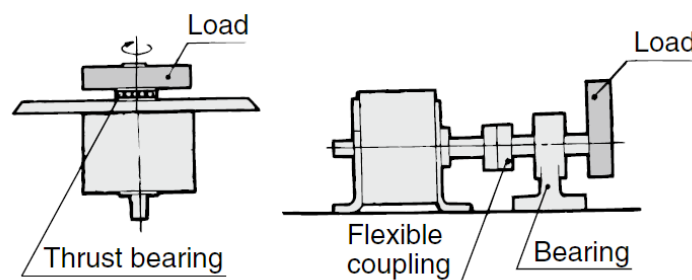
If the hole diameter is enlarged, the product's rotation speed will increase, causing the shock force to increase and damage to the product. As a result, it could pose a hazard to humans and damage the machinery and equipment.

### **9. If shaft couplings are used, use those with angular freedom.**

If shaft couplings that lack angular freedom are used, they could scrape due to eccentricity, leading to equipment malfunction and product damage. As a result, it could pose a hazard to humans and damage the machinery and equipment.

### **10. Do not apply to the shaft a load that exceeds the values given in a catalog.**

If a load that exceeds the allowable value is applied to the product, it could lead to equipment malfunction, a hazard to humans and damage to the machinery and equipment. Provided that a dynamic load is not generated, a load that is within the allowable radial / thrust load can be applied. However, applications in which the load is applied directly to the shaft should be avoided whenever possible. The methods such as those described below are recommended to prevent the load from being applied directly to the shaft in order to ensure a proper operating condition.



### **11. Do not use springs, etc., to add force in the rotational movement direction.**

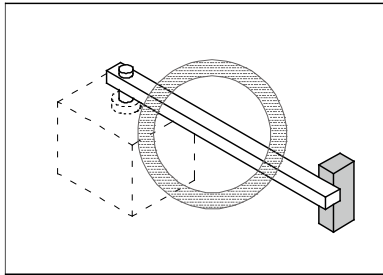
When rotational force from an external spring, etc., acts and generates negative pressure on the product's interior, breakage of the internal seal or acceleration of abrasion may occur.

## 12. Place an external stopper in a position that is away from the rotating table.

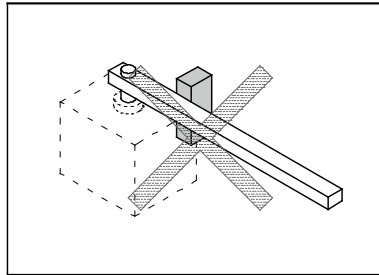
If the stopper is placed near the rotating table, the torque that is generated by the product itself will cause the reaction force which is directed to the stopper to be redirected and applied to the rotating table. This will lead to the breakage of the rotating table and bearing. As a result, it could pose a hazard to humans and damage the machinery and equipment.

### Precautions when Using External Stoppers

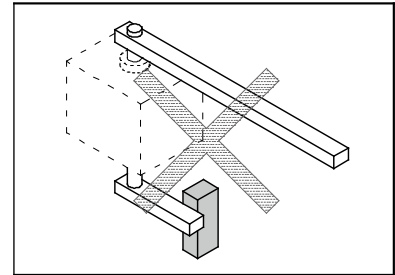
- Be sure to install external stoppers in the proper places. Installation in the wrong place can result in equipment breakage, which could damage other equipment or cause human injury.



Install the stopper at a sufficient distance from the rotating shaft.

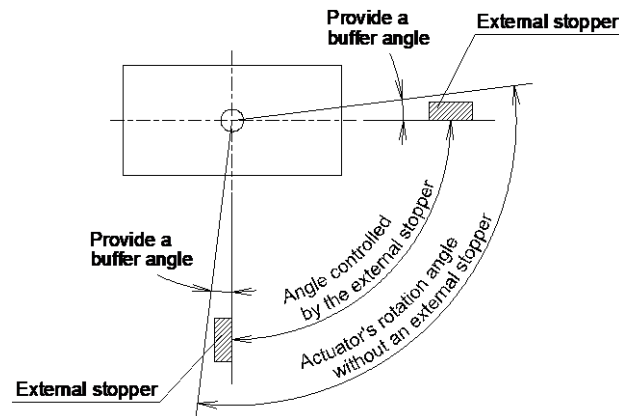


The external stopper becomes a fulcrum, resulting in the load's inertia force being applied to the table as a being moment.



If an external stopper is installed on the opposite side of the load, the inertia force generated by the load is applied directly to the table.

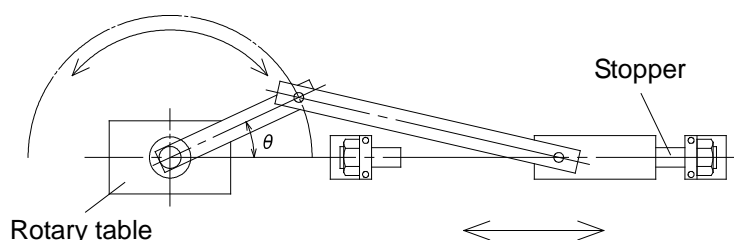
- Install external stoppers within the range of the rotating angle.  
Installing an external stopper at the maximum rotation angle may result in an inability to fully absorb the kinetic energy generated, and damage to equipment may occur.
- Angle adjustment is available for this product. When using an external stopper, set in a position so that that the adjusting bolt does not collide into the piston.



### Precautions when Converting Rotational Motion to Linear Motion

When using a link mechanism, etc., to convert rotational motion to linear motion, and determining the operation end using the stopper on the linear motion end (see below), a small value for  $\theta$  at the operation end may result in the torque of the rotary table causing excessive radial load to act on the output axle, and equipment breakage may occur.

Install a stopper on the rotation motion side, or increase the value of  $\theta$  at the operation end, to make sure the load generated does not exceed the allowable value for the product.





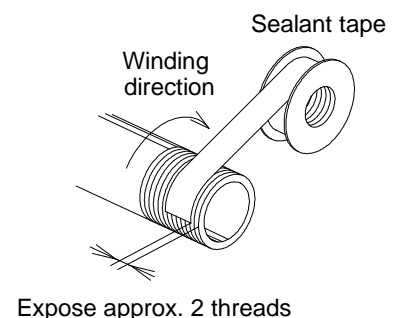
## Caution

1. **Do not use organic solvent to wipe the area of the name plate that shows the model.**  
It will erase what is indicated on the name plate.
2. **Do not hit the rotating table by securing the body or hit the body by securing the rotating table.**  
These actions could cause the table to bend or damage the bearing.
3. **Do not place your foot directly on the table or on the equipment that is coupled to the table.**  
Placing one's weight directly onto the rotating table could cause the rotating table or the bearing to become damaged.
4. **If a product is equipped with an angle adjustment function, use it within the specified adjustment range.**  
If the product is used outside the specified adjustment range, it could lead to equipment malfunction or product damage. Refer to the product specifications for details on the adjustment range of the products.
5. **A product with an angle adjustment screw is temporarily secured at an arbitrary position within the adjustable rotating range. Before using product, readjust it to a desired angle and tighten the screw firmly.**

### Piping

## Caution

1. **Refer to the Fittings and Tubing Precautions (Best Pneumatics No.7) for handling one touch fittings.**
2. **Preparation before piping**  
Before piping is connected, it should be thoroughly blown out with air (flushing) or washed to remove chips, cutting oil and other debris from inside the pipe.
3. **Wrapping of pipe tape**  
When screwing piping or fittings into ports, ensure that chips from the pipe threads or sealing material do not enter the piping. Also, if tape is used, leave 1.5 to 2 thread ridges exposed at the end of the threads.



### Speed and Cushion Adjustment

## Warning

1. **To make a speed adjustment, gradually adjust starting from the low speed end.**  
If the speed adjustment is performed from the high speed end, it could damage the product. As a result, it could pose a hazard to humans and damage the machinery and equipment.

2. For products with shock absorbers, when the shock absorber stops motion before reaching the stroke end using a stopper mechanism with the objective of shortening tact time be sure the shock absorber is stopped in a position where it has adequately absorbed the kinetic energy.

Failure to do so can result in damage to equipment.

3. **Note that a product with a shock absorber is not designed to achieve shock-less, smooth stop operation and constant deceleration of a load. The product absorbs the kinetic energy of a load to prevent its damage.**

### Lubrication

## **Warning**

1. This product should be used without lubrication. Although it will operate even if it is lubricated, it could lead to sticking or slipping.

### Air Supply

## **Warning**

#### 1. **Type of fluids**

Please consult with SMC when using the product in applications other than compressed air.

#### 2. **When there is a large amount of moisture**

Compressed air containing a large amount of moisture can cause malfunction of pneumatic equipment. An air dryer or water separator should be installed upstream from filters.

#### 3. **Drain flushing**

If condensation in the drain bowl is not emptied on a regular basis, the bowl will overflow and allow the condensation to enter the compressed air lines. This may cause malfunction of pneumatic equipment. If the drain bowl is difficult to check and remove, installation of a drain bowl with an auto drain option is recommended.

#### 4. **Use clean air.**

Do not use compressed air that contains chemicals, synthetic oils including organic solvents, salt or corrosive gases, etc., as it can cause damage or malfunction.

## **Caution**

1. **When extremely dry air is used as the fluid, degradation of the lubrication properties inside the equipment may occur, resulting in reduced reliability (or reduced service life) of the equipment. Please consult with SMC.**

#### 2. **Install an air filter.**

Install an air filter upstream near the valve. Select an air filter with a filtration size of 5µm or smaller.

#### 3. **Take measures to ensure air quality, such as by installing an aftercooler, air dryer, or water separator.**

Compressed air that contains a large amount of moisture can cause malfunction of pneumatic equipment such as rotary tables. Therefore, take appropriate measures to ensure air quality, such as by providing an aftercooler, air dryer, or water separator.

#### 4. **Ensure that the fluid and ambient temperature are within the specified range.**

If the fluid temperature is 5°C or less, the moisture in the circuit could freeze, causing damage to the seals and equipment malfunction. Therefore, take appropriate measures to prevent freezing.

## Operating Environment

### **Warning**

1. **Do not use in an atmosphere having corrosive gases, chemicals, sea water, water, steam, or where there is direct contact with any of these.**

Refer to the construction for information on the rotary table material.

2. **Do not expose the product to direct sunlight for an extended period of time.**
3. **Do not use in a place subject to heavy vibration and/or shock.**
4. **Do not mount the product in locations where it is exposed to radiant heat.**
5. **Do not use in dusty locations or where water oil, etc., splash on the equipment.**

## Maintenance

### **Warning**

1. **Perform maintenance inspection according to the procedures indicated in the operation manual.**

If handled improperly, malfunction and damage of machinery or equipment may occur.

2. **Maintenance work**

If handled improperly, compressed air can be dangerous. Assembly, handling, repair and element replacement of pneumatic systems should be performed by a knowledgeable and experienced person.

3. **Drain flushing**

Remove drainage from air filters regularly.

4. **Removal of equipment, and supply/exhaust of compressed air**

When components are removed, first confirm that measures are in place to prevent workpieces from dropping, run-away equipment, etc. Then, cut off the supply pressure and electric power, and exhaust all compressed air from the system using the residual pressure release function.

When machinery is restarted, proceed with caution after confirming that appropriate measures are in place to prevent cylinders from sudden movement.

### **Caution**

1. **For lubrication, use the designated grease for each specific product.**

The use of a non-designated lubricant could damage the seals.

Please refer to Table 13 on page 37 for where to apply grease and the grease to use.

## **Auto Switches Precautions**

### **Design / Selection**

#### **Warning**

**1. Confirm the specifications.**

If the product is used with excess load applied or beyond the specification range, this may cause the product to break or malfunction. We do not guarantee against any damage if the product is used outside of the specification range.

**2. Cautions for use in an interlock circuit**

When an auto switch is used for an interlock signal requiring high reliability, devise a double interlock system to avoid trouble by providing a mechanical protection function, or by also using another switch (sensor) together with the auto switch.

Also, perform regular maintenance and confirm proper operation.

**3. Do not attempt to disassemble, modify (including exchanging the printed circuit boards), or repair the product.**

An injury or failure can result.

#### **Caution**

**1. Pay attention to the length of time that a switch is ON at an intermediate stroke position.**

When an auto switch is placed at an intermediate position of the stroke and a load is driven, at the time the piston passes the auto switch will operate, but if the speed is too great the operating time will be shortened and the load may not operate properly.

The maximum piston speed is:

$$V(\text{mm/s}) = \frac{\text{Auto switch operating range (mm)}}{\text{Load applied time (ms)}} \times 1000$$

**2. Take precautions when multiple rotary tables are used close together.**

When multiple auto switch rotary tables are used in close proximity, magnetic field interference may cause the auto switches to malfunction. Maintain a minimum cylinder separation of 40 mm. (When the allowable interval is specified for each cylinder series, use the indicated value.)

The auto switches may malfunction due to interference from the magnetic fields.

Use of a magnetic screen plate (MU-S025) or commercially available magnetic screen tape can reduce the interference of magnetic force.

**3. Ensure sufficient clearance for maintenance activities.**

When designing an application, be certain to allow sufficient clearance for maintenance.

**4. Do not mount rotary table with the auto switch on a footing.**

If work personnel gets on or puts the work personnel's foot on the footing accidentally, an excessive load is applied to the rotary table, causing the rotary table to break.

**5. Design the circuit so that any back-flow current does not flow in if a short-circuit trouble occurs or forced operation is performed to check the operation.**

If a back-flow current occurs, this may cause the switch to malfunction or break.

**6. Limitations on detectable position**

There are positions or surfaces (bottom surface of the foot bracket, etc.) where the auto switch cannot be mounted due to the physical interference depending on the rotary table mounting status or mounting bracket. Select an appropriate auto switch setting position where the auto switch does not interfere with the rotary table mounting bracket (trunnion or reinforcing ring) after checking it sufficiently.

## 7. Keep wiring as short as possible.

### <Reed>

As the length of the wiring to a load gets longer, the rush current at switching ON becomes greater, and this may shorten the product's life. (The switch will stay ON all the time.)

- 1) Use a contact protection box when the wire length is 5m or longer.
- 2) Even if an auto switch has a built-in contact protection circuit, when the wiring is more than 30m long, it is not able to adequately absorb the rush current and its life may be reduced.

It is again necessary to connect a contact protection box in order to extend its life. Please consult SMC in this case.

### <Solid state>

Be sure to use a wire length 100m or less.

When the wire length is long, we recommend the ferrite core should be attached to the both ends of the cable to prevent excess noise. A contact protection box is not necessary for solid state switches due to the nature of this product construction.

## 8. Do not use a load that generates surge voltage.

### <Reed>

If a surge voltage is generated, the discharge occurs at the contact, possibly resulting in the shortening of product life.

If driving a load such as a relay that generates a surge voltage, use an auto switch with built-in contact protection circuit or use a contact protection box.

### <Solid state>

If driving a load such as a relay that generates a surge voltage, use a built-in surge absorbing element type device.

## 9. Pay attention to the internal voltage drop of the auto switch.

### <Reed>

- 1) Auto switch with an indicator light

- If auto switches are connected in series as shown below, take note that there will be a large voltage drop because of internal resistance in the light emitting diodes. (Refer to the internal voltage drop in the auto switch specifications.)

[The voltage drop will be "n" times larger when "n" auto switches are connected.]

Even though an auto switch operates normally, the load may not operate.



- In the same way, when operating under a specified voltage, although an auto switch may operate normally, the load may not operate. Therefore, the formula below should be satisfied after confirming the minimum operating voltage of the load.

$$\text{Supply voltage} - \text{Internal voltage drop of auto switch} > \text{Minimum operating voltage of load}$$

- 2) If the internal resistance of a light emitting diode causes a problem, select an auto switch without an indicator light.

### <Solid state / 2-wire type>

Generally, the internal voltage drop of the solid state auto switch is larger than that of the reed auto switch. When the auto switches ("n" pcs.) are connected in series, the voltage drop is multiplied by "n". In this case, the auto switches operate correctly, but the loads may not operate. Additionally, note that the 12 VDC relay does not apply to the auto switch.

## 10. Pay attention to leakage current.

### <2-wire type>

Current (leakage current) flows to the load to operate the internal circuit even when in the OFF state.

$$\text{Operating current of load (OFF condition)} > \text{Leakage current}$$

If the criteria given in the above formula are not met, it will not reset correctly (stays ON). Use a 3-wire switch if this specification will not be satisfied.

Moreover, leakage current flow to the load will be “n” times larger when “n” auto switches are connected in parallel.

## 11. Output operation of the solid state auto switch is not stable for 50 [ms] after powered ON.

In the output operation immediately after powered ON or AND connection operation, the input device (PCL or relay, etc.) may judge the ON position as OFF output or the OFF position as ON output. So, please make the setting on the equipment so that the input judgement signal is set disabled for 50 [ms] immediately after powered ON or AND connection. When using SMC's AHC system (Auto Hand Changing System) Series MA, please also make this setting.

## Mounting / Adjustment

### **Warning**

#### 1. Do not drop or bump.

Do not drop, bump or apply excessive impacts (300m/s<sup>2</sup> or more for reed auto switches and 1000m/s<sup>2</sup> or more for solid state auto switches) while handling. Although the body of the auto switch may not be damaged, the inside of the auto switch could be damaged and cause malfunction.

#### 2. Observe the proper tightening torque for mounting an auto switch.

When an auto switch is tightened beyond the range of tightening torque, auto switch mounting screws, auto switch mounting brackets or auto switch may be damaged.

On the other hand, tightening below the range of tightening torque may allow the auto switch to slip out of position.

#### 3. Do not carry a rotary table by the auto switch lead wires.

This may cause disconnection of the lead wire or the internal element to break.

#### 4. Do not use screws other than the set screws installed on the auto switch body to secure the auto switch.

If using other screws, auto switch may be damaged.

#### 5. Mount an auto switch at the center of the operating range.

In the case of 2-color display auto switch, mount it at the center of the green LED illuminating range.

Adjust the mounting position of the auto switch so that the piston stops at the center of the operating range. (The mounting position shown in the catalog indicates the optimum position at stroke end.)

If mounted at the end of the operating range (around the borderline of ON and OFF), operation will be unstable depending of the operating environment. Also there are some rotary tables with individual setting methods for auto switches. If so, mount it in accordance with the indicated method.

**Even if 2-color indication solid state auto switches are fixed at a proper operating range (the green light lights up), the operation may become unstable depending on the installation environment or magnetic field disturbance.**

(Magnetic body, external magnetic field, proximal installation of rotary tables with built-in magnet and actuators, temperature change, other factors for magnetic force fluctuation during operation, etc.)

**6. Check the actual actuation status and adjust the auto switch mounting position.**

According to the installation environment, the rotary table may not operate even at its proper mounting position. Even when setting at a midpoint of the stroke, check the actuation status and make the adjustment in the same manner.

**7. Be very careful when handling the auto switch mounting band, as it has a thin structure.**

## Wiring

### **Warning**

**1. Confirm proper insulation of wiring.**

If there is any improper insulation (mixed contact with other circuit, grounding fault, or improper insulation between terminals, etc.) in the wiring, an over-current flows in, causing the auto switch to break.

**2. Wire separately from power lines of high voltage lines, avoiding parallel wiring of wiring in the same conduit with these lines.**

If an inrush current is generated, the noise may cause the auto switch to malfunction.

**3. Be certain to connect the load before power is applied.**

**<2-wire type>**

If the power is turned ON when an auto switch is not connected to a load, the auto switch will be instantly damaged because of excess current (short circuit).

It is the same as when the 2-wire brown lead wire (+, output) is directly connected to the (+) power supply terminal.

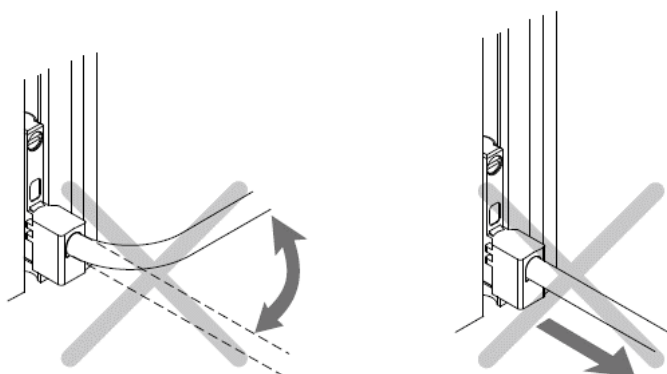
**4. Carry out the wiring work after shutting down the power.**

If the wiring work is performed with the power turned ON, this may cause electric shock, malfunction, or damage to the auto switch.

**5. Avoid repeatedly bending or stretching lead wires.**

Broken lead wires will result from repeatedly applying bending stress or stretching force to the lead wires.

Stress and tensile force applied to the connection between the lead wire and auto switch increases the possibility of disconnection.



**6. Do not allow short-circuit of loads.**

**<Reed>**

If the power is turned ON with a load in a short circuit condition, the switch will be instantly damaged because of excess current flow into the switch.

**<Solid state>**

PNP output type auto switches do not have built-in short circuit protection circuits.

Carefully handle as the auto switch may be damage.

## 7. Avoid incorrect wiring.

### <Reed>

A 24 VDC auto switch with indicator light has polarity. The brown lead wire or terminal No.1 is (+), and the blue lead wire or terminal No.2 is (—).

- 1) If connections are reversed, an auto switch will operate, however, the light emitting diode will not light up.

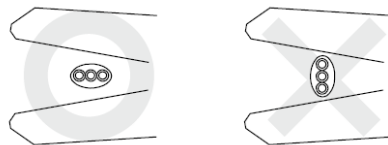
Also, take note that a current greater than that specified will damage a light emitting diode and it will no longer operate.

Applicable model: D-93, A93V

### <Solid state>

- 1) If connections are reversed on a 2-wire type auto switch, the auto switch will not be damaged if protected by a protection circuit, but the auto switch will always stay in an ON state. However, it is still necessary to avoid reversed connections, since the auto switch could be damaged by a load short circuit in this condition.
- 2) If connections are reversed (power supply line + and power supply line—) on a 3-wire type auto switch, the auto switch will be protected by a protection circuit. However, if the power supply line (+) is connected to the blue wire and the power supply line (—) is connected to the black wire, the auto switch will be damaged.

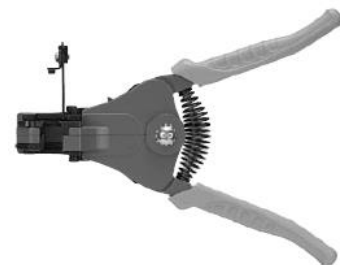
## 8. When the lead wire sheath is stripped, confirm the stripping direction. The insulator may be split or damaged depending on the direction. (D-M9□ only)



### Recommended Tool

Description	Model
Wire stripper	D-M9N-SWY

\* Stripper for a round cable (Ø2.0) can be used for a 2-wire type cable.



## Operation Environment

### ⚠ Warning

#### 1. Never use in an atmosphere with explosive gases.

The structure of auto switches is not intended to prevent explosion. This may lead to explosion hazard. Please contact SMC concerning ATEX compliant products.

### ⚠ Caution

#### 1. Do not use in an area where a magnetic field is generated.

Auto switches will malfunction or magnets inside rotary tables will become demagnetized. (Please consult with SMC if a magnetic field resistant auto switch can be used.)



**2. Do not use in an environment where the auto switch will be continually exposed to water.**

Although auto switches satisfy IEC standard IP67 construction expect some models (D-A3□, A44□, G39□, K39□, RNK, RPK) do not use auto switches in applications where continually exposed to water splash or splay. This may cause improper insulation or malfunction.

**3. Do not use in an environment with oil or chemicals.**

If auto switches are used in an environment containing coolant, cleaning solvent, various oils, or chemicals even for a short period of time, this may adversely affect the auto switches, resulting in improper insulation, malfunction due to swelling of the potting resin, or hardening of the lead wires.

**4. Do not use in an environment with temperature cycles.**

If temperature cycles other than normal temperature changes are applied, this may adversely affect the insides of the auto switches.

**5. Do not use in an environment where there is excessive impact shock.**

**<Reed>**

When excessive impact ( $300\text{m/s}^2$  or more) is applied to a reed auto switch during operation, the contacts may malfunction and generate or cut off a signal momentarily (1ms or less). Please consult with SMC if a solid state auto switch can be used according to the environment.

**6. Do not use in an area where surges are generated.**

**<Solid state>**

If there is an equipment unit (electromagnetic lifter, high-frequency induction furnace, motor, or radio, etc.) that generates large surges or electromagnetic waves around cylinders with solid state auto switches or actuators, this may cause the circuit element inside the auto switch to break.

**7. Avoid accumulation of iron waste or close contact with magnetic substances.**

If many iron particles, such as cutting chips or spatters accumulate around a cylinder with the auto switches or an actuator or if a magnetic substance (attracted by a magnet) is put close to a cylinder with the auto switch or an actuator, the magnetic force inside the cylinder or actuator loses, causing the auto switch to malfunction.

**8. Please contact SMC concerning water resistance, elasticity of lead wires, usage at welding sites, etc.**

**9. Do not use in direct sunlight.**

**10. Do not mount the product in locations where it is exposed to radiant heat.**

**11. Take appropriate measures against the lightning surge on the equipment side as the auto switches do not have any lightning surge resistance specified in the CE marking.**

## Maintenance

# **Warning**

**1. Removal of equipment, and supply/exhaust of compressed air.**

Before any machinery or equipment is removed, first ensure that the appropriate measures are in place to prevent the fall or erratic movement of driven objects and equipment, then cut off the electric power and reduce the pressure in the system to zero. Only then should you proceed with the removal of any machinery and equipment.

When machinery is restarted, proceed with caution after confirming that appropriate measures are in place to prevent rotary tables from moving suddenly.

**2. Do not touch a terminal during energizing.**

Touching a terminal during energizing may cause electric shock, malfunction, or auto switch breakage.

## Caution

1. **Perform the following maintenance periodically in order to prevent possible danger due to unexpected auto switch malfunction.**
  - 1) Secure and tighten auto switch mounting screws.  
If screws become loose or the mounting, position is dislocated, retighten them after readjusting the mounting position.
  - 2) Confirm that there is no damage to lead wires.  
To prevent faulty insulation, replace auto switches or repair lead wires, etc., if damage is discovered.
  - 3) Confirm the detection setting position.
    - Red light of 1-color display auto switch  
Confirm that the set position stops at the center of the operating range (red display area).
    - Conform the green light and position of the 2-color display auto switch.  
Conform that the set position stops at the center of the appropriate operating range (green display area). If stopped with the red LED lit, the operation may become unstable due to effects of the equipment environment or external disturbance. So, set the mounting position at the center of the appropriate operating range again.
2. **Do not use solvents such as benzene, thinner etc. to clean the product.**  
They could damage the surface of the body and erase the markings on the body. For heavy stains, use a cloth lightly dampened with diluted neutral detergent, then wipe up any residue with a dry cloth.

### Handling Precautions

## Caution

1. **The protective cover supplied with the product when D-A9□ or D-A9□V is shipped from the factory is intended to absorb the impact generated by handling and prevent the auto switch holding screw from falling. Do not remove this cover until immediately before installing the auto switch on the rotary table.**

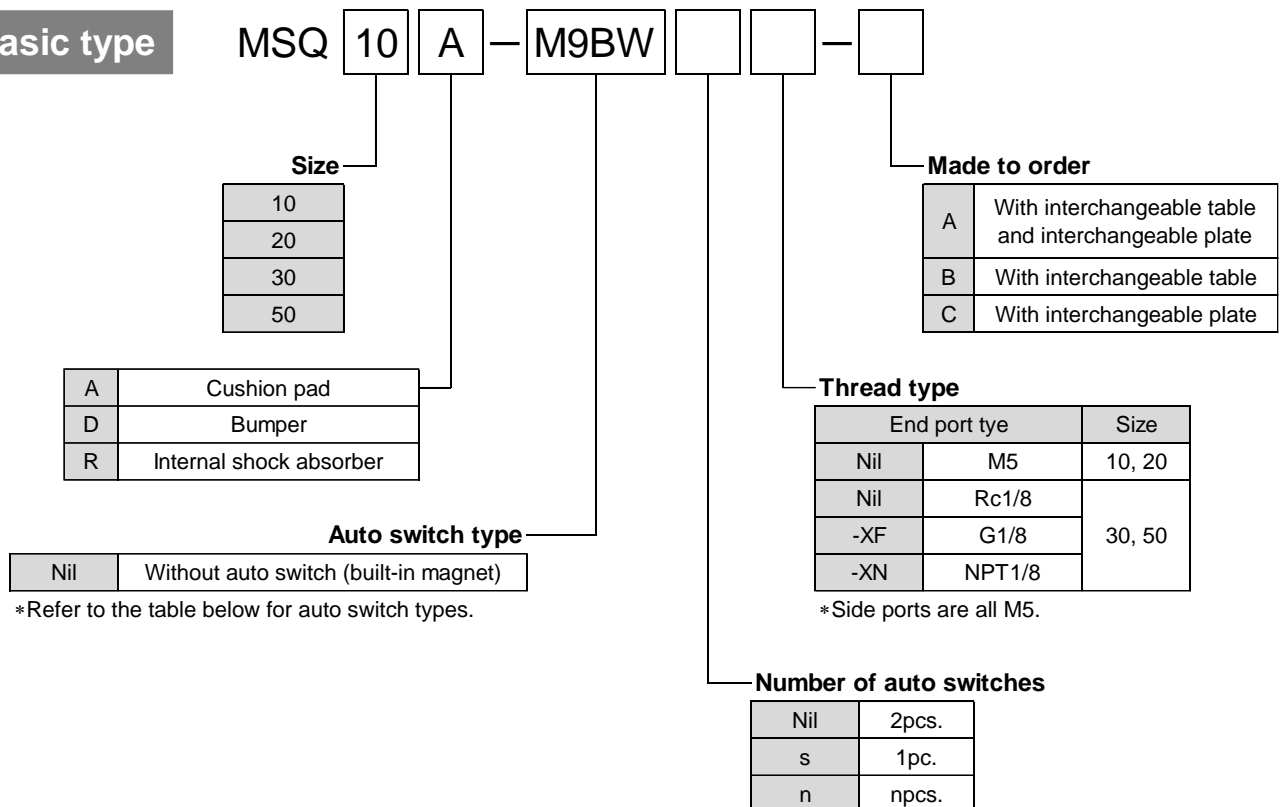
# Outline

This operation manual explains “Rack and Pinion Type Rotary table”.

When using the product, load (moment of inertia), rotation time and other factors have to be considered. So, confirm the specification of the product prior to use.

## How to order

### Basic type



### Applicable Auto Switches / Refer to the website catalog for detailed auto switch specification.

Applicable Auto Switches																
Refer to the website catalog for detailed auto switch specification.																
Type	Special function	Electrical entry	Indicator light	Wiring (Output)	Load voltage			Auto switch model		Lead wire length (m)				Pre-wire connector	Applicable load	
					DC	AC		Perpendicular	In-line	0.5 (Nil)	1 (M)	3 (L)	5 (Z)			
Solid state auto switch	—	Grommet	Yes	3-wire(NPN)	24V	5V, 12V	—	M9NV	M9N	●	●	●	○	○	IC circuit	Relay, PLC
				3-wire(PNP)		12V		M9PV	M9P	●	●	●	○	○		
				2-wire		12V		M9BV	M9B	●	●	●	○	○		
	Diagnostic indication (2-color indicator)			3-wire(NPN)	24V	5V, 12V		M9NWV	M9NW	●	●	●	○	○	IC circuit	
				3-wire(PNP)		12V		M9PWV	M9PW	●	●	●	○	○		
				2-wire		12V		M9BWV	M9BW	●	●	●	○	○		
	Water reisstant (2-color indicator)			3-wire(NPN)	24V	5V, 12V		M9NAV <sup>*1</sup>	M9NA <sup>*1</sup>	○	○	●	○	○	IC circuit	
				3-wire(PNP)		12V		M9PAV <sup>*1</sup>	M9PA <sup>*1</sup>	○	○	●	○	○		
				2-wire		12V		M9BAV <sup>*1</sup>	M9BA <sup>*1</sup>	○	○	●	○	○		
Reed auto switch	—	Grommet	Yes	3-wire (NPN equiv.)	—	5V	—	A96V	A96	●	—	●	—	—	IC circuit	Relay, PLC
				2-wire	24V	12V	100V	A93V <sup>*2</sup>	A93	●	●	●	●	—		
			No	2-wire	24V	12V	100V or less	A90V	A90	●	—	●	—	—	IC circuit	

\*1 Although it is possible to mount water resistant type auto switches, note that the rotary actuator itself is not of water resistant construction.

\*2 1m type lead wire is only applicable to D-A93.

\*Lead wire length symbols : 0.5m ..... Nil (Example) M9NV  
 1m ..... M (Example) M9NVM  
 3m ..... L (Example) M9NWL  
 5m ..... Z (Example) M9NWZ

\*Auto switches marked with a "O" are produced upon receipt of orders.

\*Auto switches are shipped together, (but not assembled).

## Specifications

Table 1. Specifications

Size		10	20	30	50
Fluid		Air (non-lube)			
Maximum operating pressure	Cushion pad	1MPa			
	Bumper				
	Internal shock absorber	0.6MPa <sup>*1</sup>			
Minimum operating pressure		0.1MPa <sup>*2</sup>			
Ambient and fluid temperature		0 to 60°C (no freezing)			
Cushion	Cushion pad <sup>*3</sup>	Rubber cushion			
	Bumper				
	Internal shock absorber	Shock absorber			
Allowable kinetic energy	Cushion pad	0.007J	0.025J	0.048J	0.081J
	Bumper	0.014J	0.042J	0.072J	0.162J
	Internal shock absorber	0.039J	0.116J	0.116J	0.294J
Angle adjustment range		0 to 190° <sup>*4</sup>			
Maximum rotation		190°			
Rotation time adjustment range	Cushion pad	0.2 to 2.0 s/90°			
	Bumper				
	Internal shock absorber	0.2 to 0.7 s/90° <sup>*5</sup>			
Cylinder bore size		Ø13	Ø16	Ø20	Ø22
Port size	End ports	M5x0.8		Rc1/8 , G1/8 NPT1/8 , NPTF1/8	
	Side ports	M5x0.8			

\*1 The maximum operating pressure of the actuator is restricted by the maximum allowable thrust of the shock absorber.

\*2 Please refer to page 27 for the minimum operating pressure of the bumper type.

\*3 Reduces the noise which is generated when the piston and adjustment bolt collide into each other.

\*4 Be careful if the rotation angle of a type with internal shock absorber is set below the value in the table 2, the piston stroke will be smaller than the shock absorber's effective stroke, resulting in decreased energy absorption ability.

\*5 When the rotation time of the type with an internal absorber is set longer than the time shown in the table 1, energy absorption of the shock absorber greatly decreases.

Table 2. Minimum rotation angle that will not allow decrease of energy absorption ability

Size	10	20	30	50
Minimum rotation angle that will not allow decrease of energy absorption ability	40°	35°	35°	47°

## Weight

Table 3.

[g]

Size		10	20	30	50
Basic Type	Cushion pad	375	680	930	1500
	Bumper				
	Internal shock absorber	440	795	1130	1810

\* Values excluding the weight of auto switch

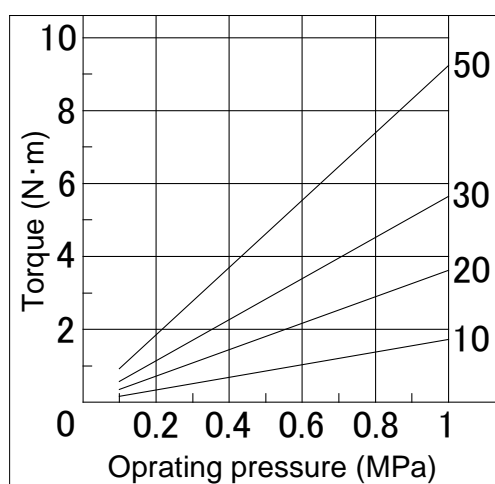
\* For order made products, add the weight shown in Table 4 to the weight of the basic type.

Table 4. Order made parts

[g]

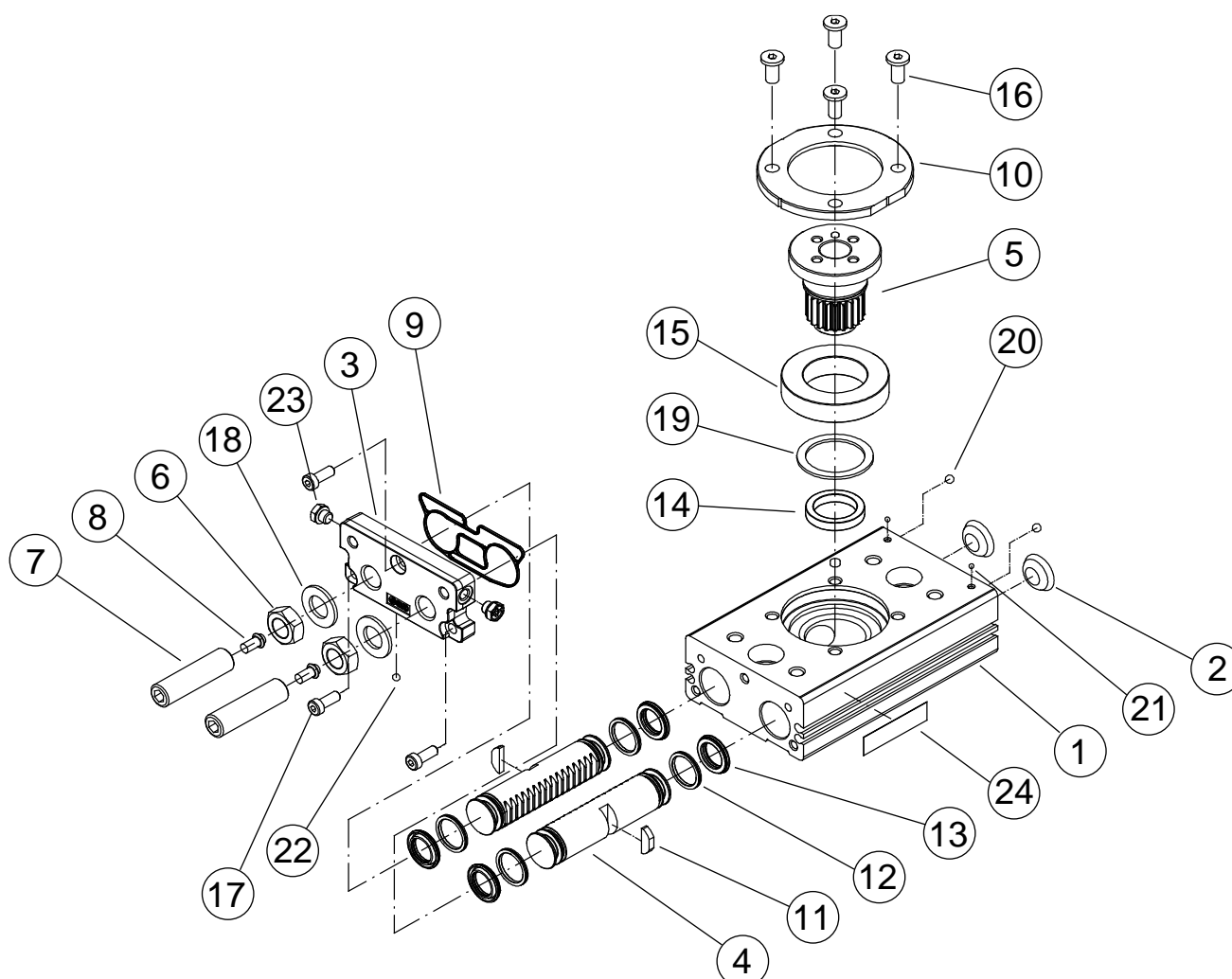
Size	10	20	30	50
With interchangeable table and interchangeable plate	70	160	120	220
With interchangeable table	30	60	80	130
With interchangeable plate	40	100	40	90

## Effective torque



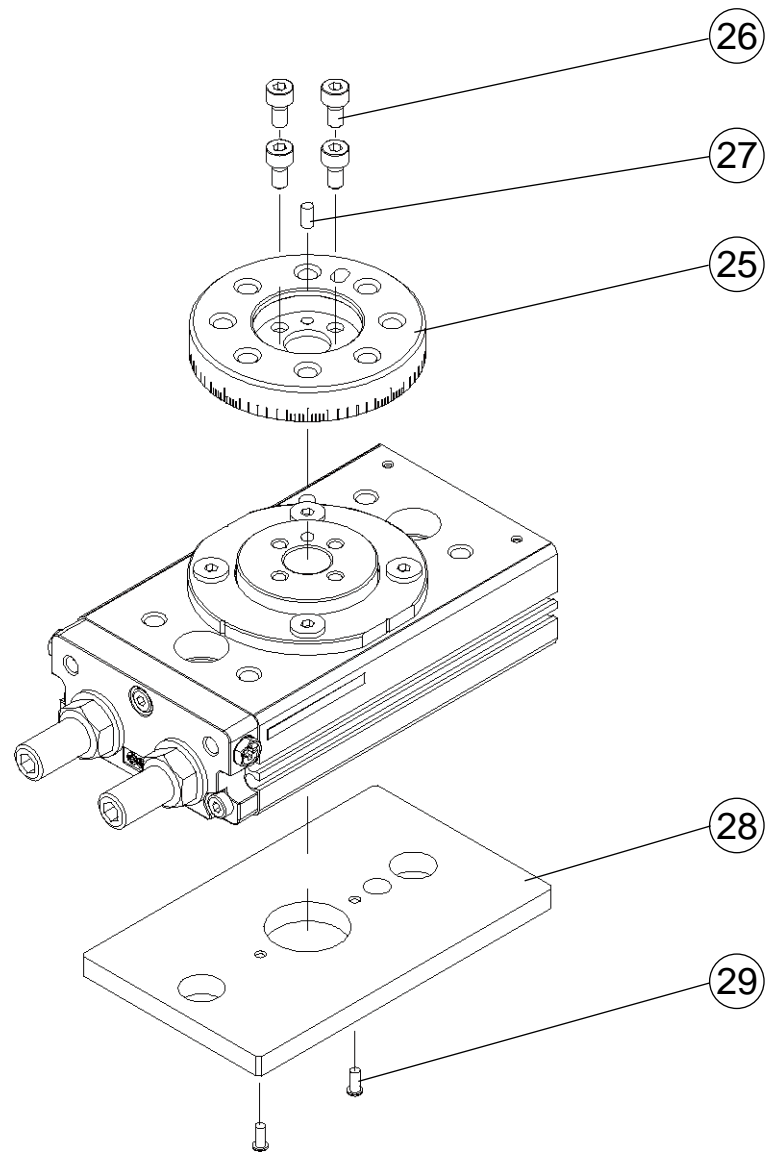
## Internal construction and parts

MSQ10 to 50



24	Product label	1	
23	M5 Plug assembly	2	
22	Steel ball	1	
21	Steel ball	2	
20	Steel ball	2	
19	Snap ring	1	
18	Seal washer	2	
17	Low head hexagon socket head cap screw	3	4pcs. for size 20, 30, 50
16	Ultra low head cap screw	4	
15	Bearing	1	
14	Bearing	1	
13	Piston seal	4	
12	Wear ring	4	
11	Magnet	1	
10	Bearing retainer	1	
9	Gasket	1	
8	Cushion pad or bumper	2	Not included in the internal absorber type
7	Adjustment bolt or shock absorber	2	
6	Compact hexagon nut	2	
5	Table pinion	1	
4	Piston	2	
3	End cover	1	
2	Head cap	2	
1	Body	1	
No	Description	Qty	Note

Made to Order



-A	With interchangeable table and interchangeable plate
-B	With interchangeable table
-C	With interchangeable plate

29	Cross recessed round head screw for precision	2	For -A, -C
28	Interchangeable plate	1	For -A, -C
27	Parallel pin	1	For -A, -B
26	Hexagon socket head cap screw	4	For -A, -B
25	Interchangeable table	1	For -A, -B
No	Description	Qty	Note

\* Refer to page21 for the components other than those above.

## Basic circuit

### Circuit structure

The standard circuit for operating a rotary cylinder with an air filter, regulator, solenoid valve and speed controller is shown in Figure 1 below.

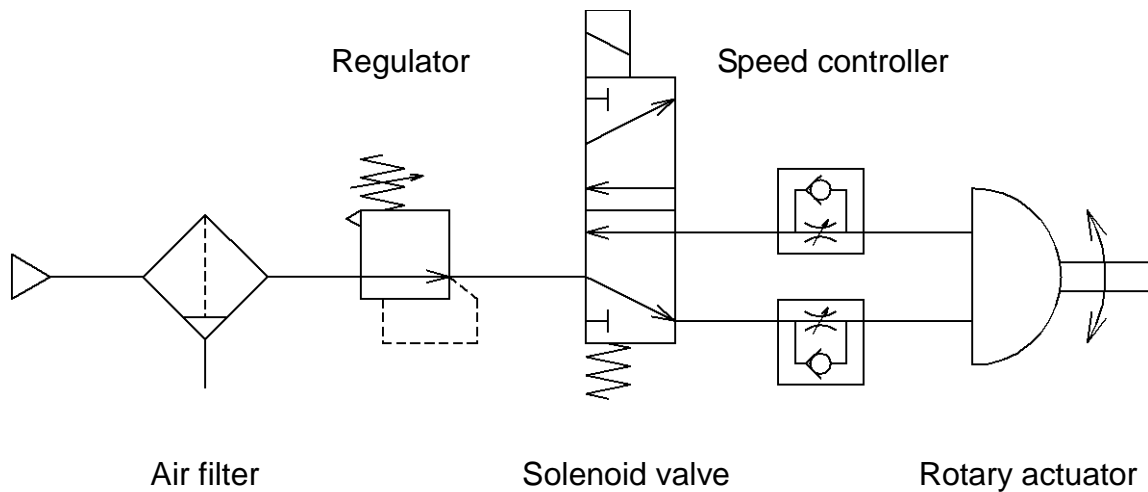


Fig.1 Basic circuit

### Recommended models

Recommended models for the standard circuit in Figure 1 are shown in Table 5 below.

Table 5. Recommended models

Size	Solenoid valve (CV value)	Speed controller	Tubing
10	0.15 to 0.2	AS1000 series	Ø4 or more
20			
30		AS2000 series	
50			



# Mounting

## Load restrictions

Set the load and moment to be applied to the table within the allowable values shown in the table below. (Values exceeding the allowable range will cause excessive play, reduce accuracy, and shorten service life.)

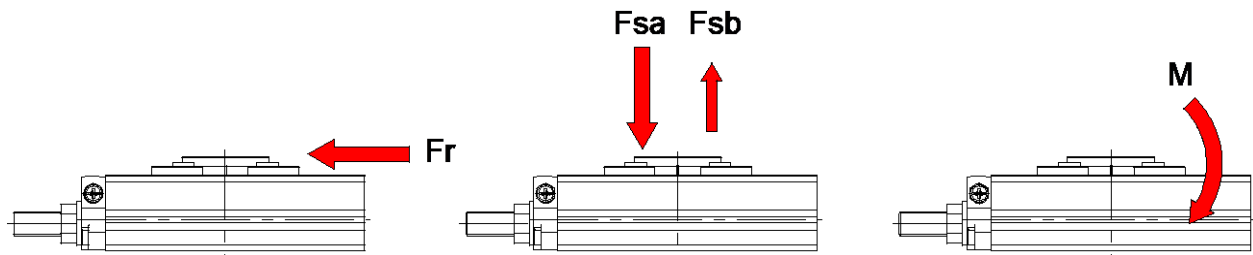


Fig. 2

Table 6. [N]

Size Basic type	Load direction			
	Fsa	Fsb	Fr	M [N·m]
10	78	74	78	2.4
20	137	137	147	4.0
30	363	197	196	5.3
50	451	296	314	9.7

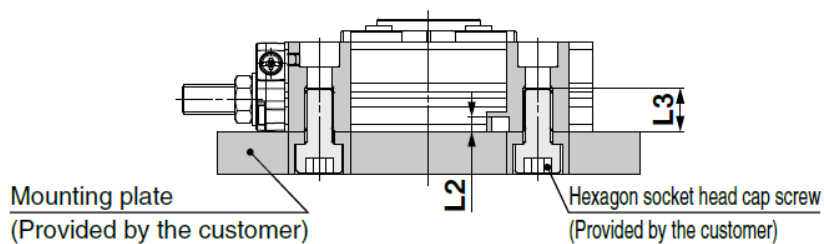
## Bolts for mounting product

When mounting the body, use screws of the appropriate length.

### Basic type

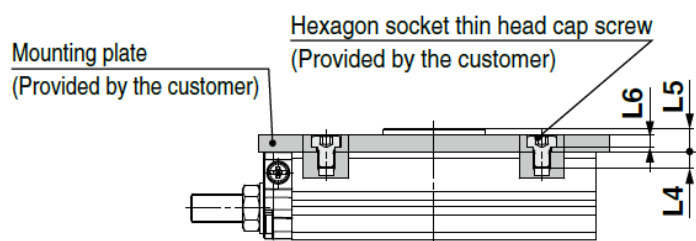
1. Top mounting (Through hole)				
<p>Hexagon socket head cap screw (Provided by the customer)</p> <p>Mounting plate (Provided by the customer)</p> <p>L1</p> <p>L2</p>				
Size	L1		L2	
	Screw	Length [mm]	Pin [mm]	Effective depth [mm]
10	M6 x 1	23.5	Ø 3	3.5
20	M8 x 1.25	22.5	Ø 4	4.5
30	M8 x 1.25	29.5	Ø 4	4.5
50	M10 x 1.5	32.5	Ø 5	5.5

## 2. Bottom mounting (Body tapped)



Size	L2		L3	
	Pin [mm]	Effective depth [mm]	Screw	Max. screw-in depth [mm]
10	Ø 3	3.5	M8 x 1.25	12
20	Ø 4	4.5	M10 x 1.5	15
30	Ø 4	4.5	M10 x 1.5	15
50	Ø 5	5.5	M12 x 1.75	18

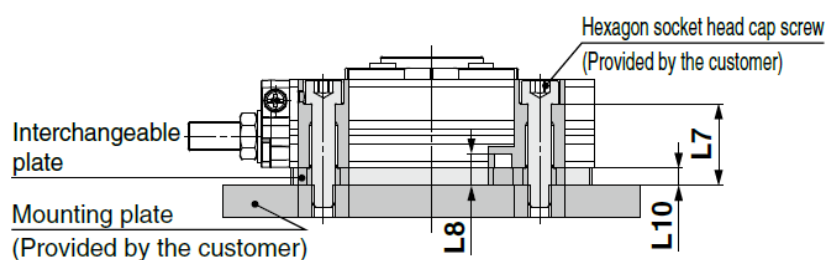
## 3. Top mounting (Body tapped)



Size	L4		L5	L6
	Screw	Max. screw-in depth [mm]	Height [mm]	Counterbore depth [mm]
10	M5 x 0.8	6	6	3.9
20	M6 x 1	6	8	4.5
30	M6 x 1	6	8	4.5
50	M8 x 1.25	8	8.5	5.6

■ With interchangeable plate

#### 4. Top mounting (Through hole)

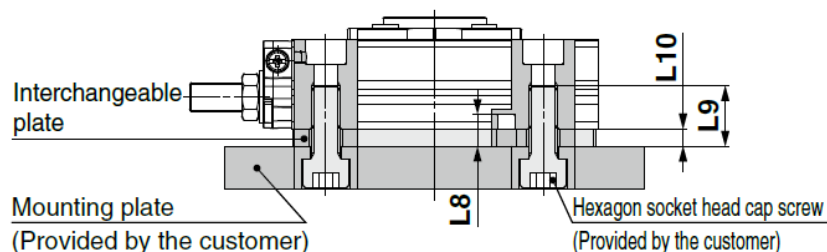


Size	L7		L8		L10
	Screw	Length [mm]	Pin [mm]	Depth* <sup>1</sup> [mm]	Plate thickness [mm]
10	M6 x 1	28	Ø 3	8	4.5
20	M8 x 1.25	28.5	Ø 4	10.5	6
30	M8 x 1.25	31.5	Ø 4	6.5	2
50	M10 x 1.5	35.5	Ø 5	8.5	3

\*1 The effective depth of the pin is the depth obtained by subtracting the plate thickness (L10) from the L8 depth.

\* Refer to page 44 for the tightening torque of the interchangeable parts.

#### 5. Bottom mounting (Body tapped)



Size	L8		L9		L10
	Pin [mm]	Depth* <sup>1</sup> [mm]	Screw	Max. screw-in depth [mm]	Plate thickness [mm]
10	Ø 3	8	M8 x 1.25	16.5	4.5
20	Ø 4	10.5	M10 x 1.5	21	6
30	Ø 4	6.5	M10 x 1.5	17	2
50	Ø 5	8.5	M12 x 1.75	21	3

\*1 The effective depth of the pin is the depth obtained by subtracting the plate thickness (L10) from the L8 depth.

\* Refer to page 44 for the tightening torque of the interchangeable parts.

## Rotation direction and rotation angle

- When the cylinder is pressurized from port B, the table rotates clockwise.
- To obtain the desired rotation angle, the rotation ends can be set within the range shown in the diagram by regulating the adjustment bolt or shock absorber.

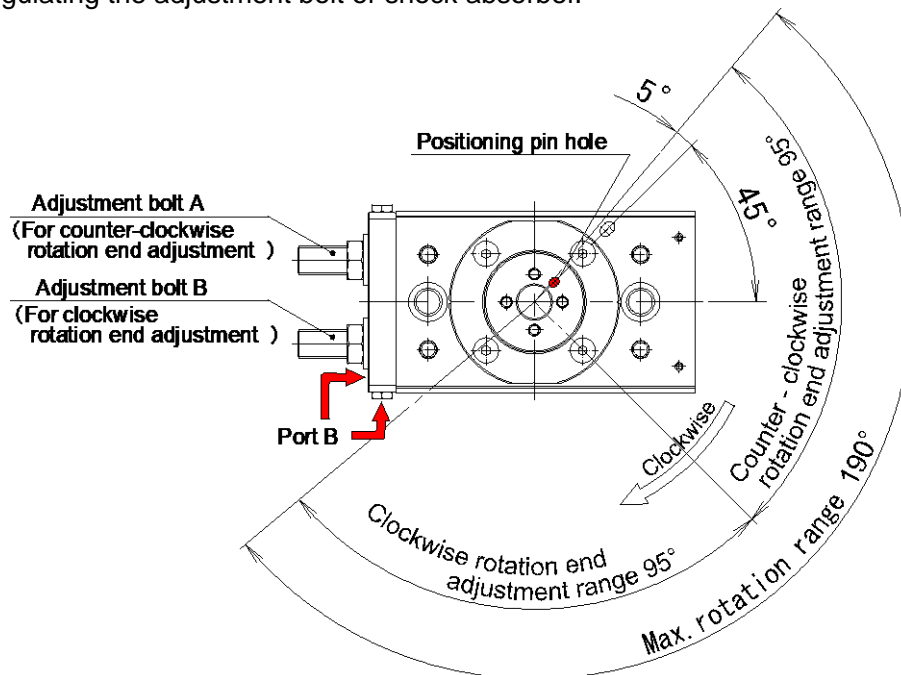


Fig. 3 Rotation direction and rotation angle

Note)

- The drawing shows the rotation range of the positioning pin hole.
- The pin hole position in the drawing shows anticlockwise rotation end when the rotation angle is set at 180° by equally tightening the adjusting bolts A and B.
- Refer to the setting example of the rotation angle range. (Fig.4)

Table 8 shows adjusting angle per one rotation of adjust bolt (shock absorber).

Table 8. With adjustment bolt

Size	10	20	30	50
Rotation adjustment per single rotation of rotation adjustment screw	8.0°	5.7°	5.7°	6.4°

Note)

- Since the end of adjustment bolt of Series MSQ has a built-in cushion pad (or a bumper), when angle adjustment is made, push the piston completely while pressurizing (minimum operating pressure for cushion pad : 0.1MPa or more, minimum operating pressure for bumper : 0.3MPa or more) as shown in Figure 4. Please refer to page 45 for details.
- Adjustment of with internal shock absorber types should also be made by pushing the piston rod of shock absorber completely.

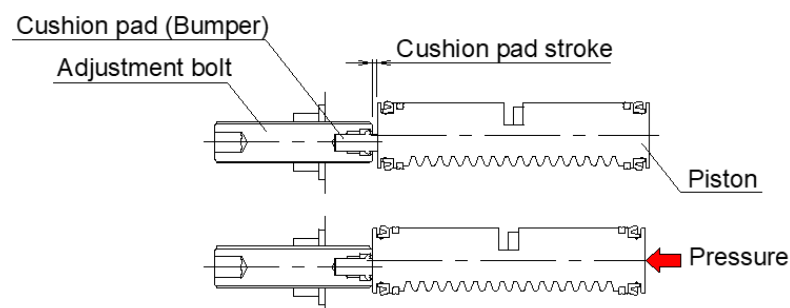


Fig. 4

## Rotating range examples

Various rotation ranges are possible as shown in the drawings below using adjustment bolts A and B. (The drawings show the rotation range of the positioning pin hole.)

The rotation angle can also be set on a type with internal shock absorber.

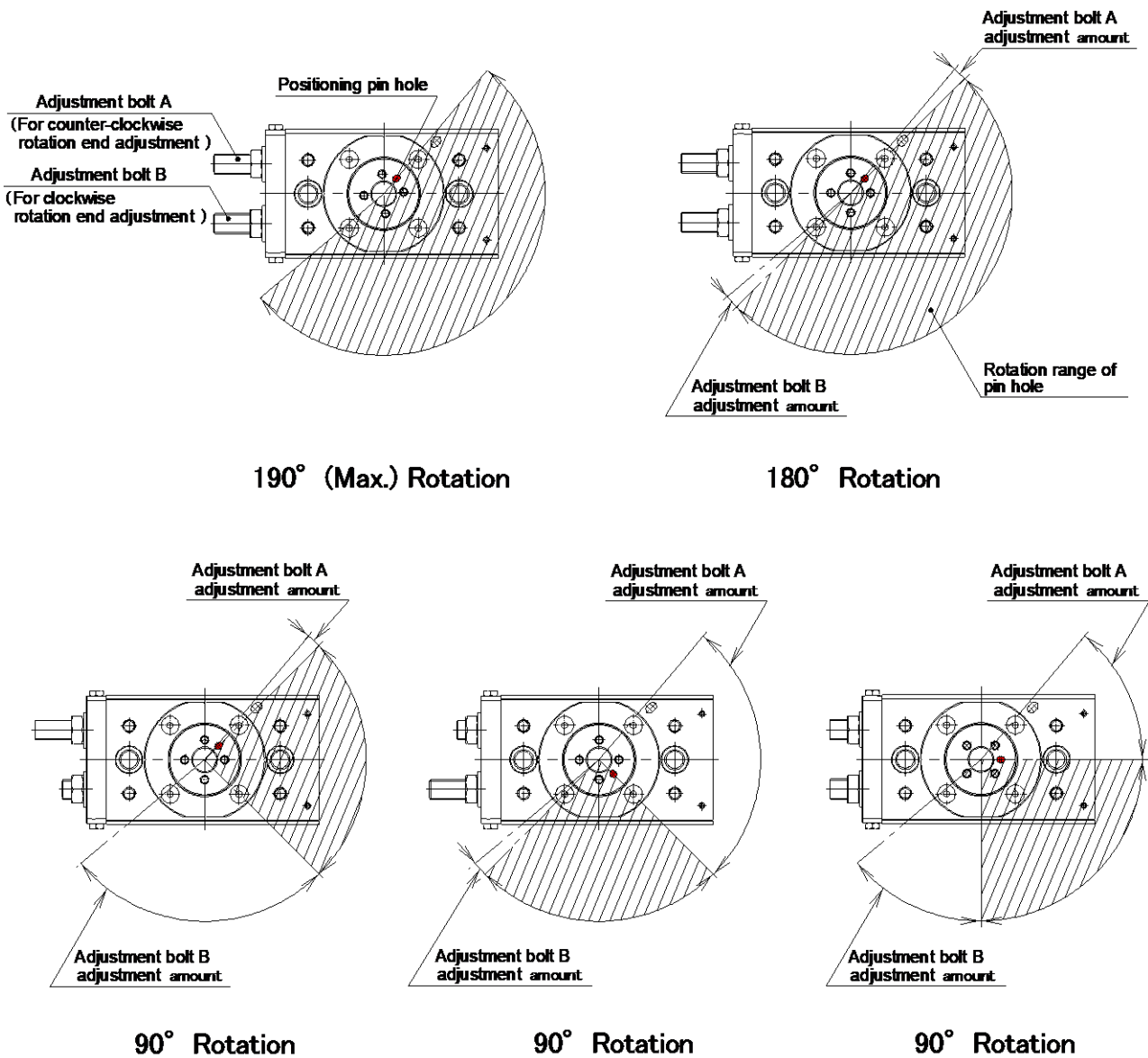


Fig. 5

### Special angle adjustment tool

If it is difficult to adjust the angle with normal tools due to the installed condition, use the special tool specified below.

Table 9 shows the part number of the special angle adjustment tool and Table 10 shows the dimensions of the special tool.

Table 9. Part number of special angle adjustment tool

Size	Part number
10	P8910195
20, 30	P8910295
50	P8910495

Table 10. Special tool dimensions

[mm]

Part number	A	B	C	D	E
P8910195	50	10	16	10	12
P8910295	60	12	18.2	11	14
P8910495	80	15	24	17	19

### Angle adjustment using the special tool

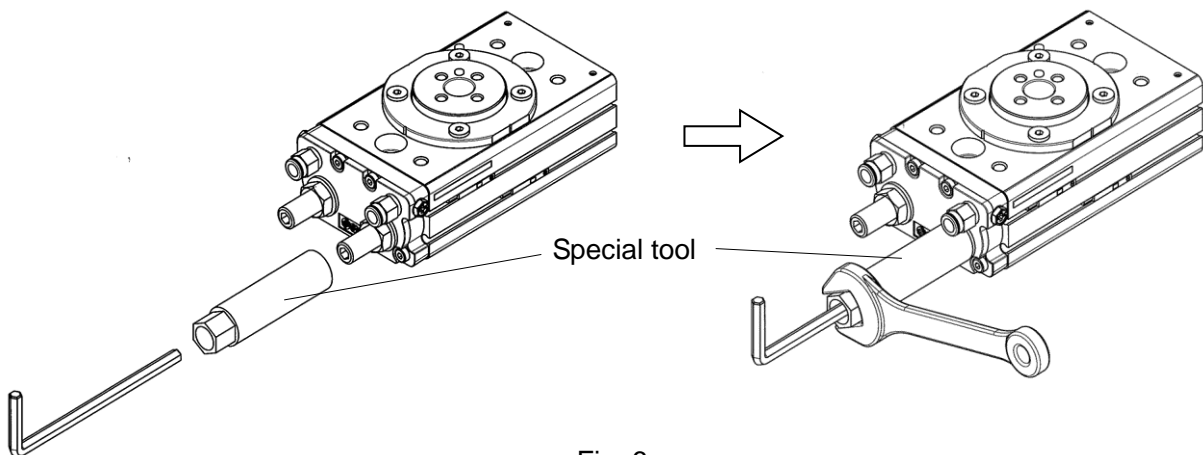


Fig. 6

## Piping

Figure 7 and Table 11 show locations and sizes of piping ports. Ports can be selected from two sides. Plug the ports that are not used.

Table 11. Port size

Size	Port size A1, B1	Port size A2, B2
10	M5x0.8	M5x0.8
20		
30	Rc1/8 G1/8 NPT1/8	
50		

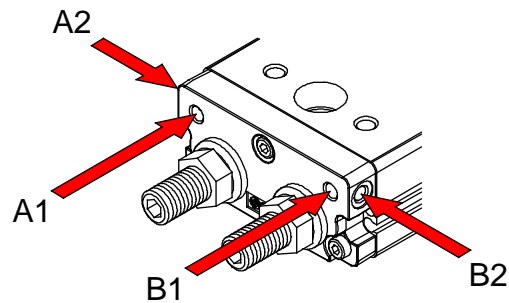


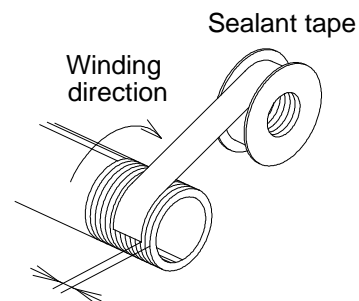
Fig. 7

Rotary table ports have a fixed orifice. Do not make the diameter of this hole larger by additional processing.

If the hole diameter is made larger, rotation speed and impact will increase, which may cause breakage of the product.

Preparation before piping.

- Before piping is connected, it should be thoroughly blown out with air to remove dust and scale from inside the pipe. Dust and scale on the inlet side of the filter can be removed, but those on the outlet side cannot be removed, so they can enter the solenoid valve or rotary table, which causes malfunction or shortens product life.
- When screwing piping or fittings into ports, ensure that chips from the pipe threads or sealing material do not enter the piping. Also, if pipe tape is used, leave 1.5 to 2 thread ridges exposed at the end of the threads.



Expose approx. 2 threads

Fig. 8 Wrapping of pipe tape

## Air supply

Air supplied to the rotary actuator shall be cleaned by the filter. MSQ series is lubrication free.

## Setting of rotation time

It is necessary to calculate the inertial load and kinetic energy in the application prior to setting the speed of the actuator. The inertial load generated in the application may be high even if the torque required in the application is low, this may lead to damage to the internal components of the actuator.

### Moment of inertia

The moment of inertia indicates how hard it is to rotate an object, and also how hard it is to stop the object once it is rotating.

Any object rotated by a rotary table will have an inertial force.

When the rotary table stops at the stroke end, the actuator will receive a big impact (kinetic energy) due to the inertial force.

Please refer below for calculation of kinetic energy.

$$E = \frac{1}{2} \cdot I \cdot \omega^2$$

E: Kinetic energy [J]

I: Moment of inertia [ $\text{kg} \cdot \text{m}^2$ ]

$\omega$ : Angle speed [ $\text{rad/s}$ ]

Allowable kinetic energy for the rotary actuator is limited. The limit of rotation time is obtained by calculating the moment of inertia.

Please refer below to calculate the moment of inertia.

Basic moment of inertia

$$I = m \cdot r^2$$

m : Weight [kg]

r : Distance of rotational axis and load center of gravity [m]

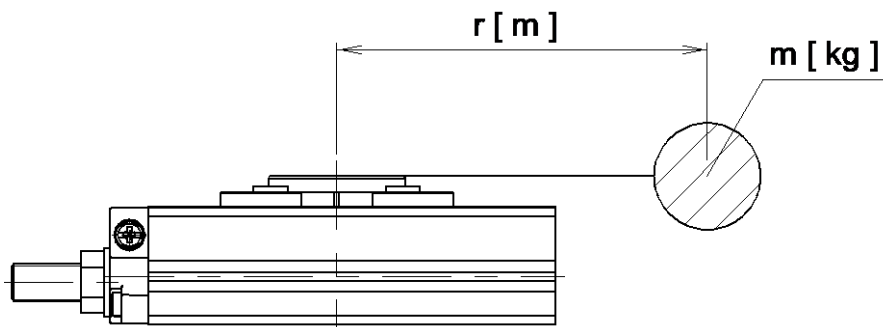


Fig. 9

This shows moment of inertia of “m (weight)” at “r” distance from the axis of rotation. The calculation for the moment of inertia depends on the shape of the object. Please refer the table on the next page for the moment of inertia calculations.

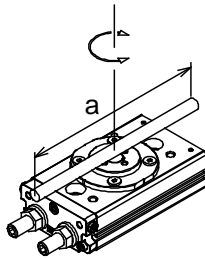


## Calculation formulae for moment of inertia

I: Moment of inertia [ kg · m<sup>2</sup> ]    m: Load mass [ kg ]

### 1. Thin shaft

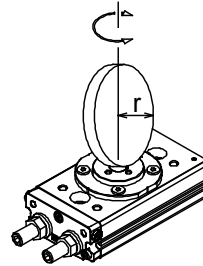
Position of rotational axis: Perpendicular to the shaft through the center of gravity



$$I = m \cdot \frac{a^2}{12}$$

### 6. Thin round plate

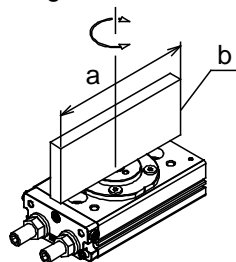
Position of rotational axis: Through the center of diameter



$$I = m \cdot \frac{r^2}{4}$$

### 2. Thin rectangular plate

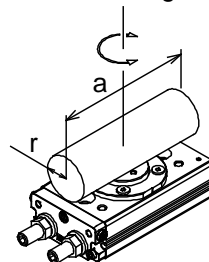
Position of rotational axis: Parallel side b and through the center of gravity



$$I = m \cdot \frac{a^2}{12}$$

### 7. Cylinder

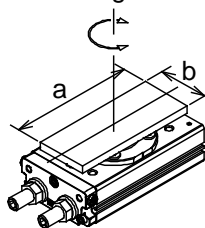
Position of rotational axis: Through the center of diameter and gravity



$$I = m \cdot \frac{3r^2 + a^2}{12}$$

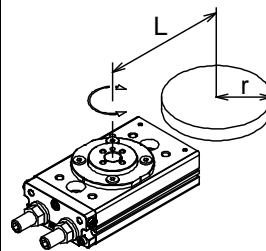
### 3. Thin rectangular plate (Including Rectangular parallelepiped)

Position of rotational axis: Perpendicular to the plate through the center of gravity



$$I = m \cdot \frac{a^2 + b^2}{12}$$

### 8. When the rotational axis and load center of gravity are not consistent



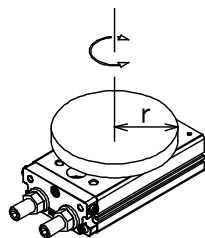
$$I = K + m \cdot L^2$$

K: Moment of inertia around the load center of gravity

4.Round plate     $K = m \cdot \frac{r^2}{2}$

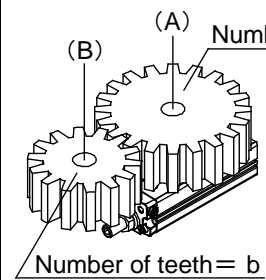
### 4. Round plate (Including column)

Position of rotational axis: Through the center axis



$$I = m \cdot \frac{r^2}{2}$$

### 9. Gear transmission

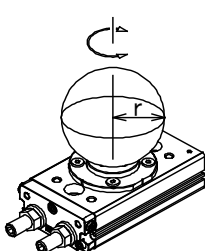


1. Find the moment of inertia  $I_B$  for the rotation of shaft (B).
2.  $I_B$  is converted to the rotation of the shaft (A).

$$I_A = \left( \frac{a}{b} \right)^2 \cdot I_B$$

### 5. Solid sphere

Position of rotational axis: Through the center of diameter



$$I = m \cdot \frac{2r^2}{5}$$

## Kinetic energy

Table 12 shows the allowable kinetic energy of the rotary table.

The end angle speed  $\omega$  is obtained by:

$$\omega = \frac{2\theta}{t}$$

$\theta$  : Rotation angle [ rad ]

$t$  : Rotation time [ s ]

Kinetic energy E is obtained by:

$$E = \frac{1}{2} \times I \times \omega^2$$

Table 12. Allowable kinetic energy [J]

Size	Allowable kinetic energy		
	With cushion pad	With bumper	With internal shock absorber
10	0.007	0.014	0.039
20	0.025	0.050	0.116
30	0.048	0.096	0.116
50	0.081	0.162	0.294

Therefore, the rotary table rotation time is:

$$t \geq \sqrt{\frac{2 \times I \times \theta^2}{E}}$$

E: Allowable kinetic energy [ J ]

$\theta$  : Rotation angle [ rad ]

I: Moment of inertia [ kg · m<sup>2</sup> ]

During uniform acceleration, the angle speed  $\omega$  after  $t$  seconds can be found as follows.

$$\omega = \dot{\omega} \cdot t \quad \dots (1)$$

$$\theta = \int \dot{\omega} dt = \frac{1}{2} \dot{\omega} t^2 + C \quad \dots (2)$$

When  $t = 0$ , rotation angle  $\theta = 0$ , so the integration constant is  $C = 0$ .

$$\theta = \frac{1}{2} \dot{\omega} t^2 = \frac{1}{2} \omega t$$

thus,

$$\omega = \frac{2\theta}{t}$$

## Auto switch

The rotary table has a magnet mounted on its piston and an auto switch on the outside of the body to detect the piston position (table position). Rotary tables have a short piston stroke, so detection should be done at the stroke end.

Refer to page 18 for mountable auto switches.

### Internal structure and operation principle

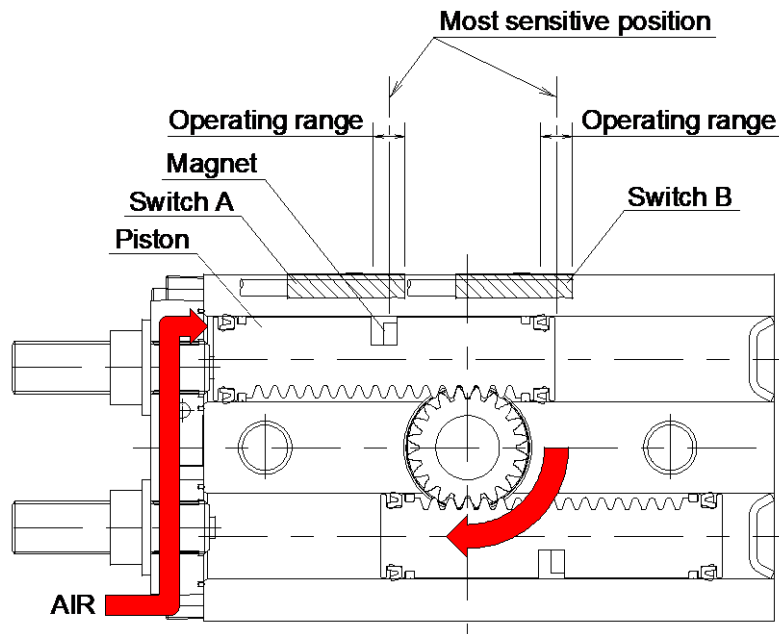


Fig. 10

When switch A is turned on and pressure is supplied in the direction indicated by the arrows in Fig. 11, the piston moves and the table rotates clockwise.

At this point, magnet A goes out of switch A's operation range to turn off switch A. Then the piston moves further, and the magnet goes into switch B's operation range to turn on switch B.

### Mounting of auto switch

When tightening the auto switch mounting screw, use a precision screwdriver with a handle of 5 to 6 mm in diameter.

Table 13 shows the recommended tightening torque.

Use the designated slotted set screw (M2.5×4L) to mount the auto switch.

Table 13. Recommended tightening torque

Auto switch model	Recommended tightening torque [N · m]
D-M9□	0.05 to 0.15
D-M9□A (Water resistant)	0.05 to 0.10
D-A9□	0.10 to 0.20

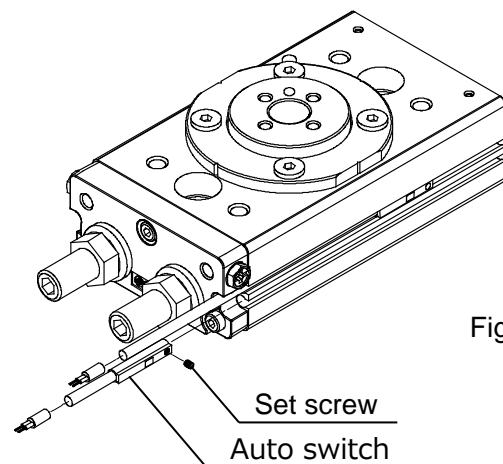


Fig. 11

## Auto switch proper mounting position at rotation end

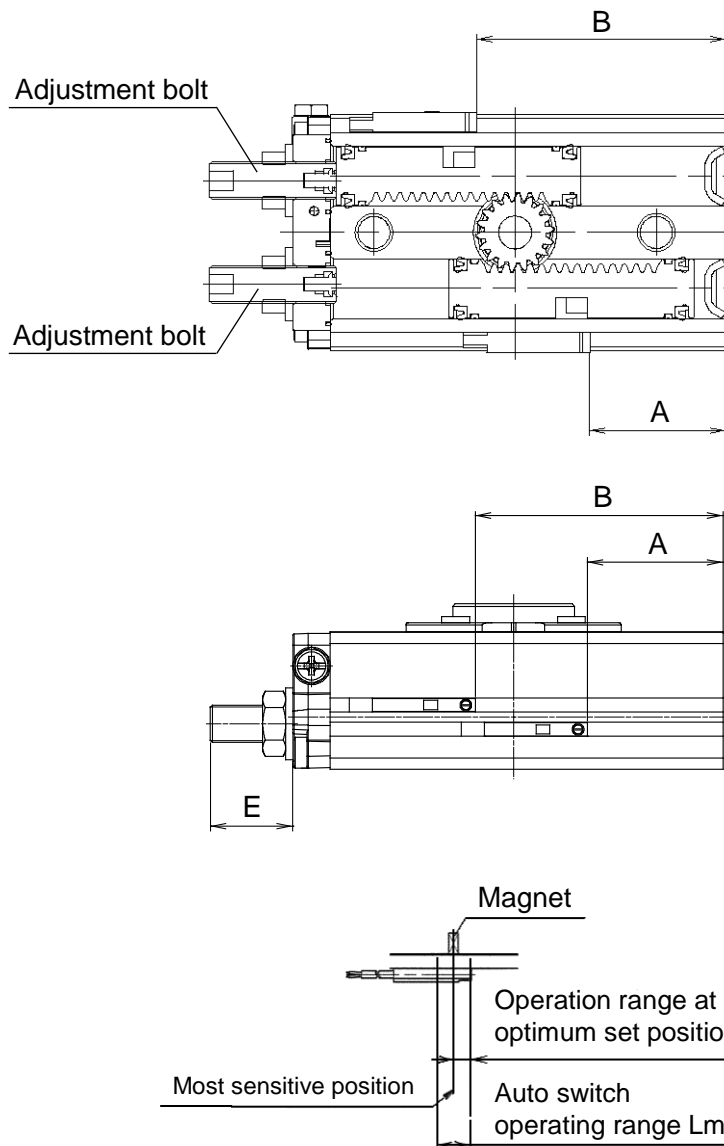


Table 14. Dimension E [mm]

Size	Adjust- ment bolt	Shock absorber
10	17	31
20	25	35
30	23	33
50	33	53

Fig. 12

Table 15. Auto Switch Operation range / Hysteresis / most sensitive position

Size	Rotation angle (deg)	Solid state switch				Reed switch			
		A (mm)	B (mm)	Operation range $\theta_m$ (deg)	Hysteresis range(deg)	A (mm)	B (mm)	Operation range $\theta_m$ (deg)	Hysteresis range(deg)
10	180	26 to 29	49 to 51	27	3	22 to 25	45 to 47	50	4
20	180	34 to 37	66 to 68	21	2	30 to 33	62 to 64	42	4
30	180	39 to 41	70 to 73	24	2	35 to 37	66 to 69	44	4
50	180	46 to 48	88 to 91	19	2	42 to 44	84 to 87	31	3

Operating range  $\theta_m$ : The value in which the auto switch operating range “Lm” is converted to axis rotating value.

Hysteresis range : Value of auto switch hysteresis converted to an angle.

Note) • The above values are only provided as a guideline, and they are not guaranteed.  
In the actual setting, adjust them after confirming the auto switch operating condition.  
• The values above show the position when the adjustment bolt (or shock absorber) is screwed in by the same amount (Refer to Table 14).

## Maintenance and Inspection

Periodic inspection is necessary for optimum use. Generally, annual inspection is recommended for the rotary table. Even if no problem is found, seal parts replacement is recommended every three years. It is highly possible that the actuator is operated out of specification when the components like table pinion, piston, bearing are broken. Please revise the operating condition. In this case, please return the broken actuator to SMC to repair.

### Regular check

Check the following for periodic inspection

- (1) If the rotary actuator set screw has become loose
- (2) If the rotary actuator set frame has become loose
- (3) Is the operation smooth?
- (4) Is there any leakage to outside?

If any items are found during the inspection that require repairing or tightening, either tighten the loose components or the rotary table must be replaced.

### Replacement procedure of the seal kit

#### Cautions for disassembly

- (1) **Disassembling the product will void SMC's warranty. If disassembly is really necessary it is recommended to fully understand the internal construction before disassembling the products.**
- (2) **Disassemble in a clean and spacious workplace.**
- (3) **Cover the rotary actuator pipe inlet and the end of rubber hose after removing the rotary table.**
- (4) **Be careful to ensure not to damage internal sliding surface of the rotary table when disassembling it.**
- (5) **Please consult with us when you have any question on disassembling and inspection.**

Table 16. Replacement parts

Description	Size											
	10			20			30			50		
Seal kit	P891010-5			P891020-5			P891030-5			P891040-5		
Parts included in seal kit	No.	Description	Qty.	No.	Description	Qty.	No.	Description	Qty.	No.	Description	Qty.
	9	Gasket	1	9	Gasket	1	9	Gasket	1	9	Gasket	1
	12	Wear ring	4	12	Wear ring	4	12	Wear ring	4	12	Wear ring	4
	13	Piston seal	4	13	Piston seal	4	13	Piston seal	4	13	Piston seal	4
	18	Seal washer	2	18	Seal washer	2	18	Seal washer	2	18	Seal washer	2

Please refer to Page 21 for the product construction.

A grease pack (10g) is included.

When only a grease pack is needed, order with the following part number.

**Grease pack part number : GR-L-010**

## ■ Disassembly procedure

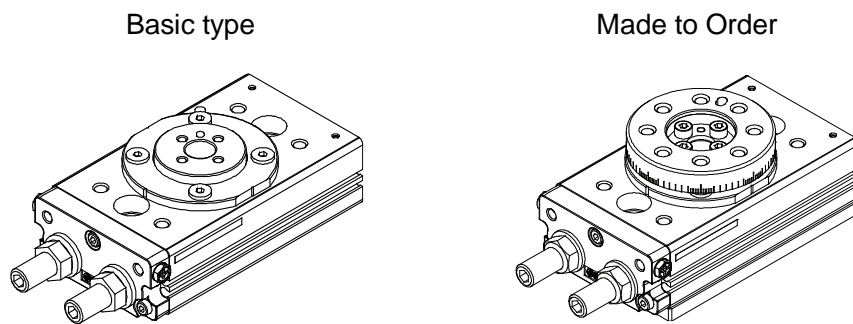


Fig. 13

- (1) Loosen the hexagon socket head cap screws and remove the interchangeable table and parallel pin.

\*Made to Order -A, -B only

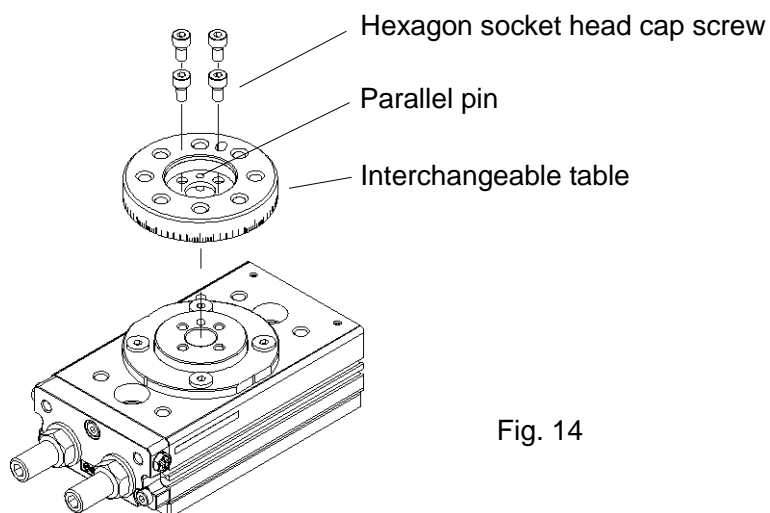


Fig. 14

- (2) Loosen the cross recessed round head screws for precision equipment and remove the interchangeable plate.

\*Made to Order -A, -C only

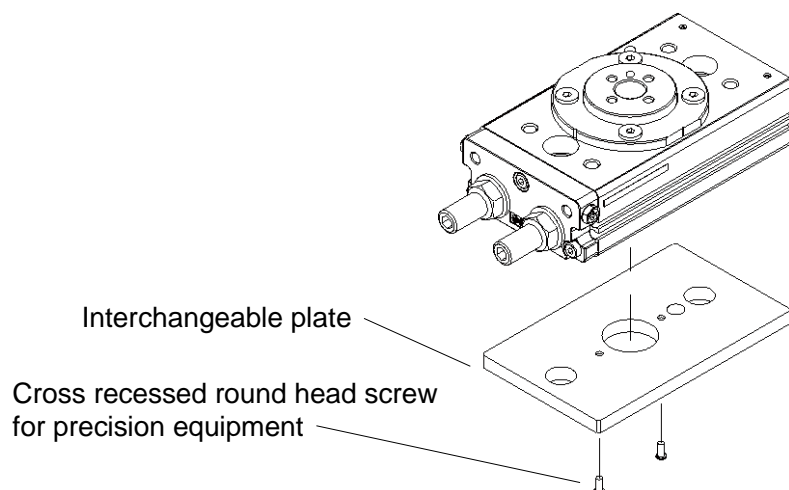


Fig. 15

(3) Loosen ultra low head cap screw to remove the bearing retainer.

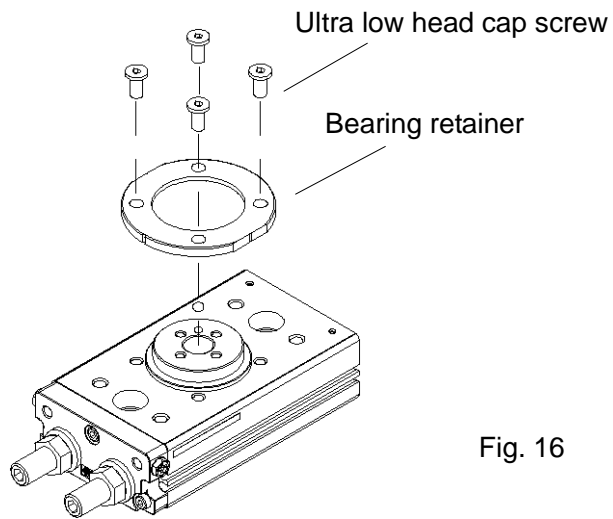


Fig. 16

(4) Pull out the table pinion from the body.

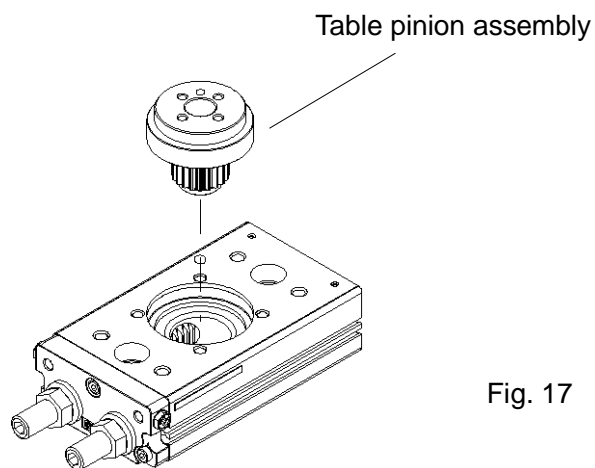


Fig. 17

(5) Loosen the low head hexagon socket head bolt to remove the end cover assembly.

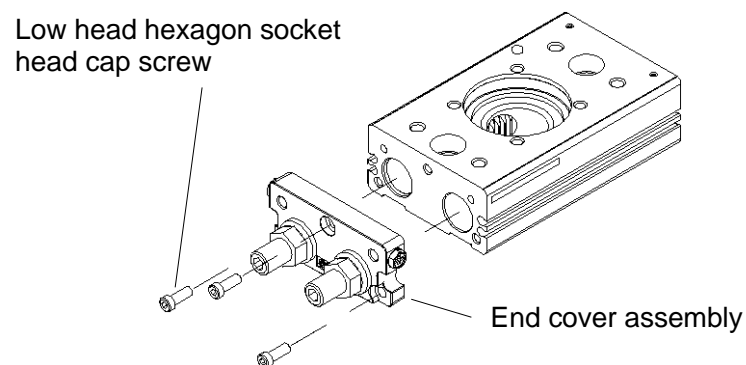


Fig. 18

- (6) Pull out the 2 piston assemblies by hooking the piston rack. (Piston assemblies are visible from the hole for the assemblies).

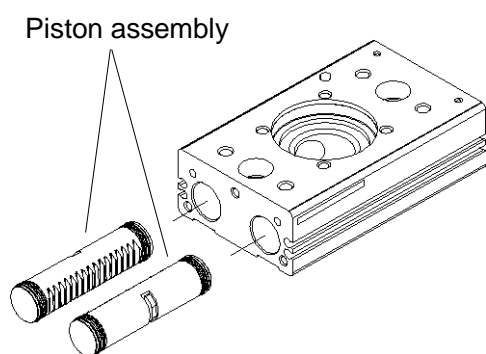


Fig. 19

- (7) Take out the bearing from the body.

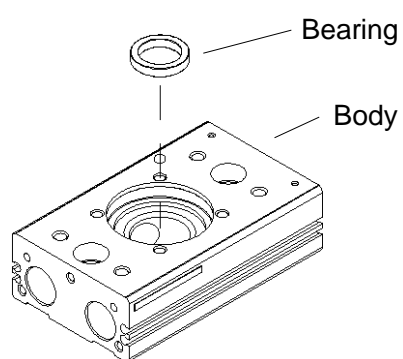


Fig. 20



## ■ Assembly procedure

- (1) Clean each component sufficiently before assembly to prevent a dust from sticking to them.  
Apply the grease which is included in the seal kit to each part shown in Table 17. The correct amount of grease to be applied should be enough so there is a thin film on the surface of components which is shiny to the eye.

Table 17. Parts where grease is to be applied

Grease applied parts	Grease
Cylinder internal surface	GR-L-010
Piston packing groove	
Piston seal	
Gasket	

## Body assembly

Apply grease after wiping the inside of the cylinder with alcohol, and mount the bearing on the housing.

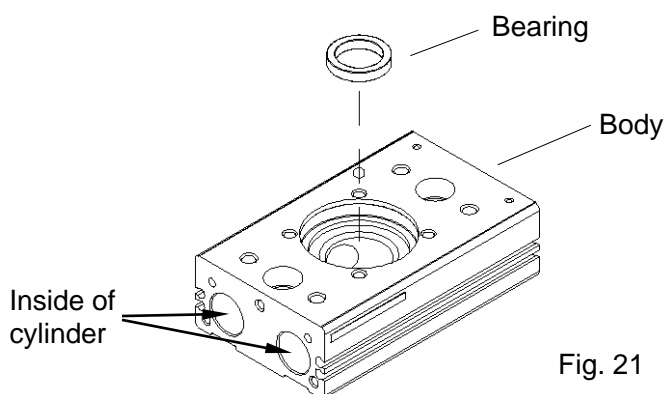


Fig. 21

## Piston assembly

Pay attention to the installation direction of the piston seal as the direction is specified.  
Then mount the piston seal to the piston, taking care not to damage the piston seal.  
Pay attention to the direction of the piston seal and wear ring (size 50 only).

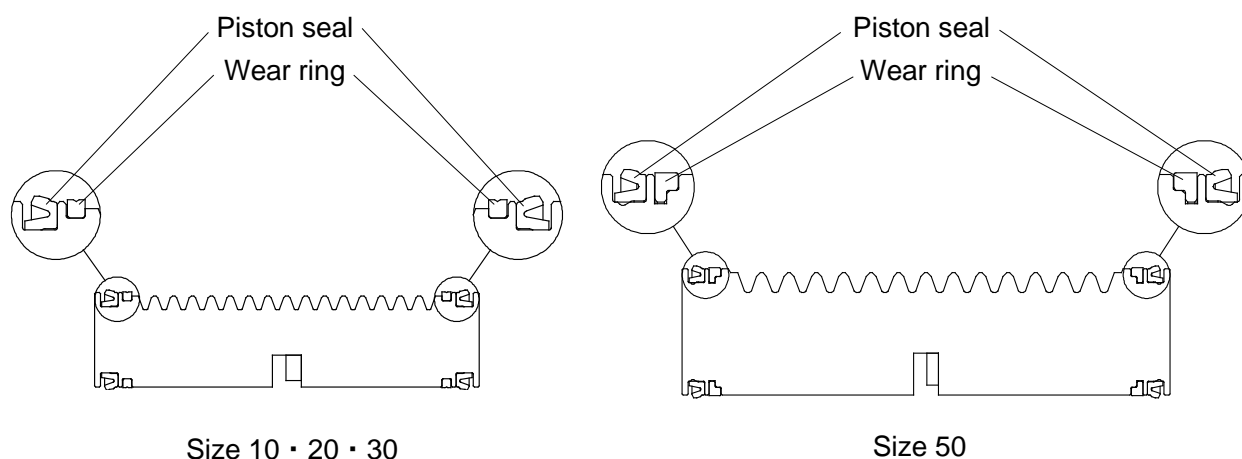


Fig. 22

## End cover assembly

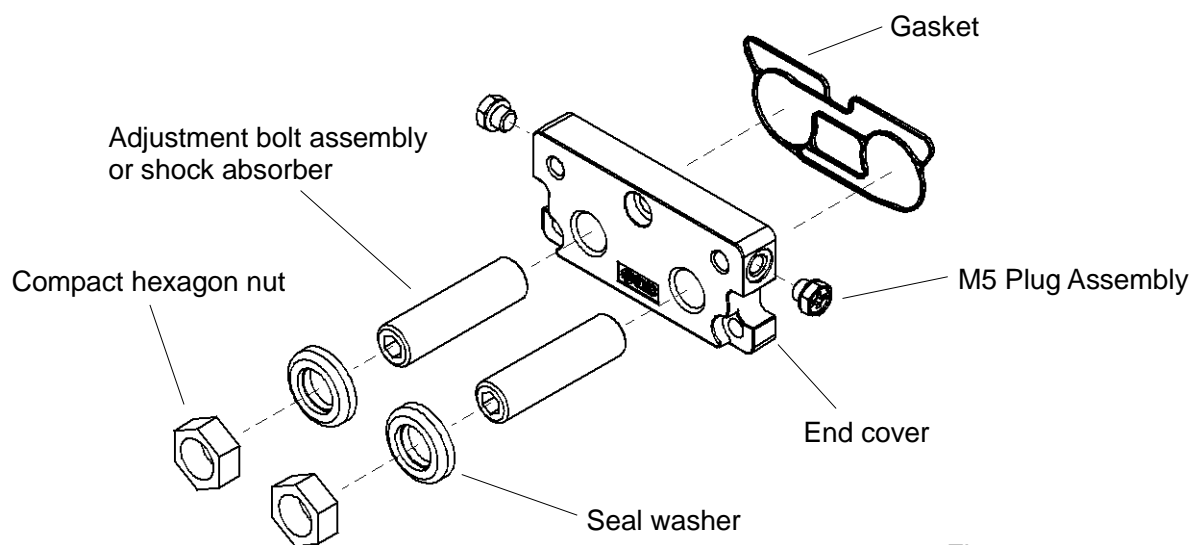


Fig. 23

Size	Recommended tightening torque [N · m]	
	Adjustment bolt assembly Shock absorber	M5 plug assembly
10	1.00 to 1.67	1.30 to 1.50
20,30	1.88 to 3.14	
50	6.48 to 10.8	

- (2) Insert the piston assembly into the body assembly. At this time, the piston seals pass the opening of the cylinder and should be pressed inward not to be cut on the edge of bore. Also, pay attention to the piston assembly does not hit the head cap.

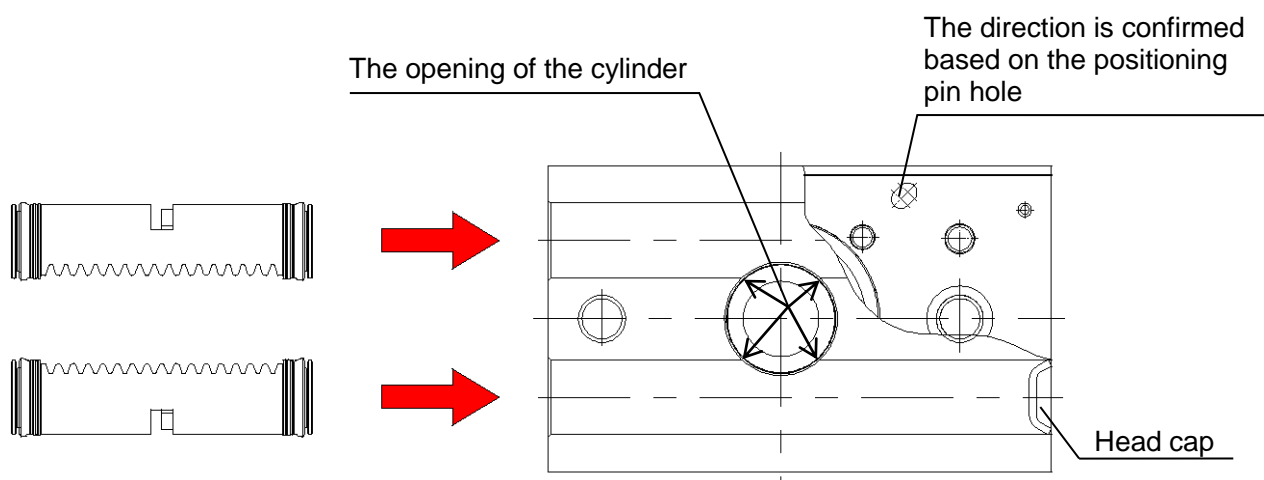


Fig. 24

(3) Hold the piston in place and install the pinion gear on the piston.

Figure 25 shows the piston position and Figure 26 shows the pinion gear assembly angle.

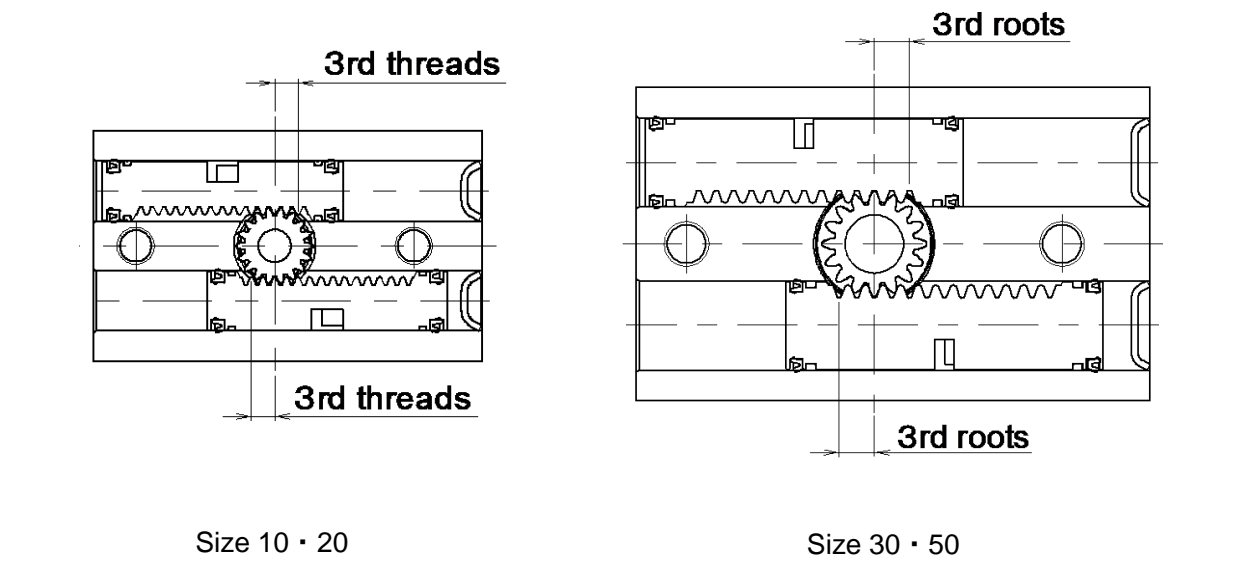


Fig. 25

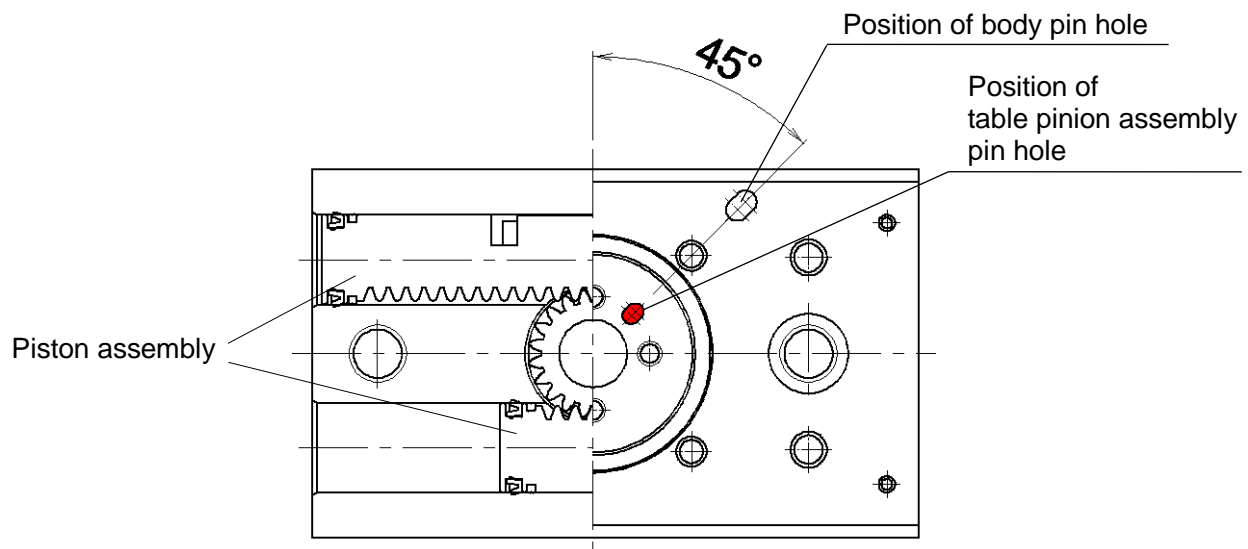


Fig. 26

- (4) Mount the table pinion and bearing retainer on the body.  
Pay attention to the direction of the bearing retainer.

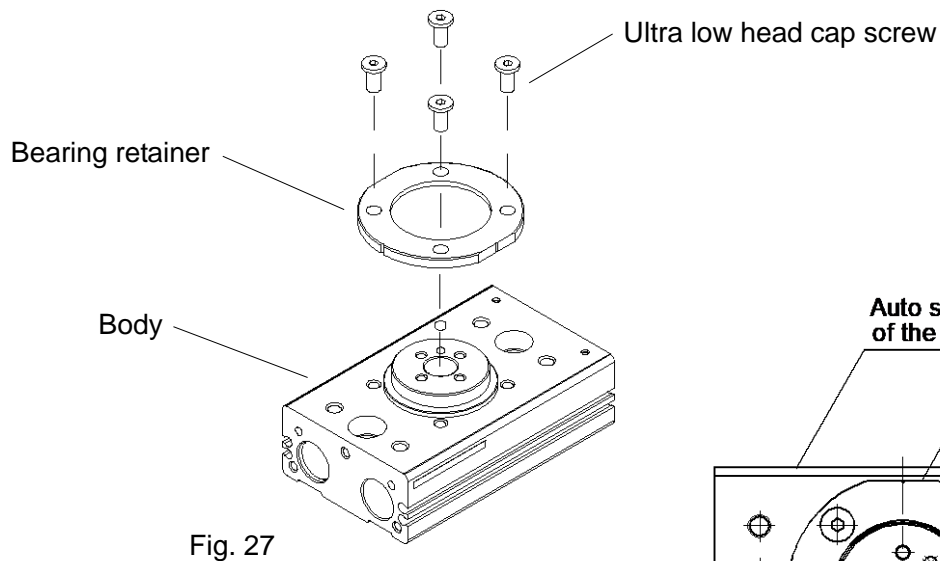


Fig. 27

Size	Recommended tightening torque [N · m]
10	0.56 to 1.00
20,30	1.94 to 3.50
50	2.78 to 5.00

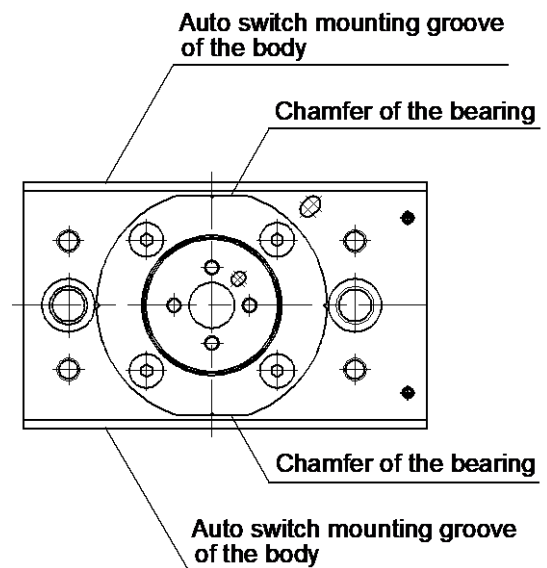


Fig. 28

- (5) Mount the end cover assembly on the body.

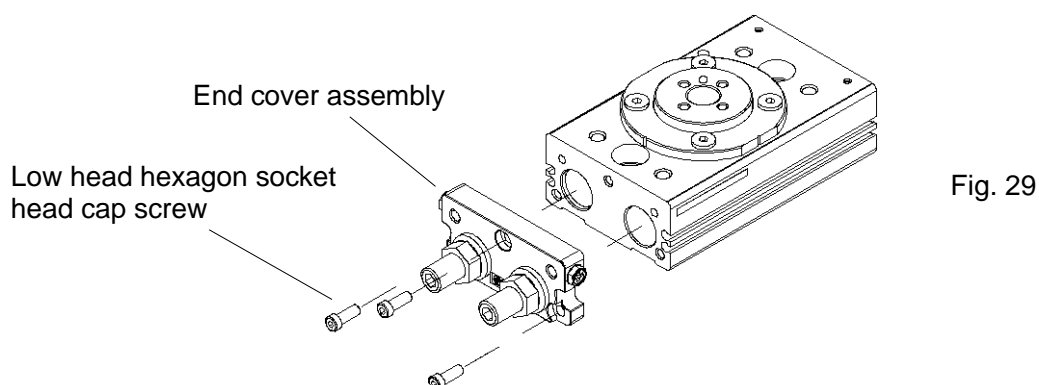


Fig. 29

Size	Recommended tightening torque [N · m]
10,20,30	1.50 to 2.70
50	3.00 to 5.40

- (6) Mount the interchangeable plate to the body.  
 Pay attention to the direction of the Interchangeable plate.  
 \*Made to Order -A, -C only

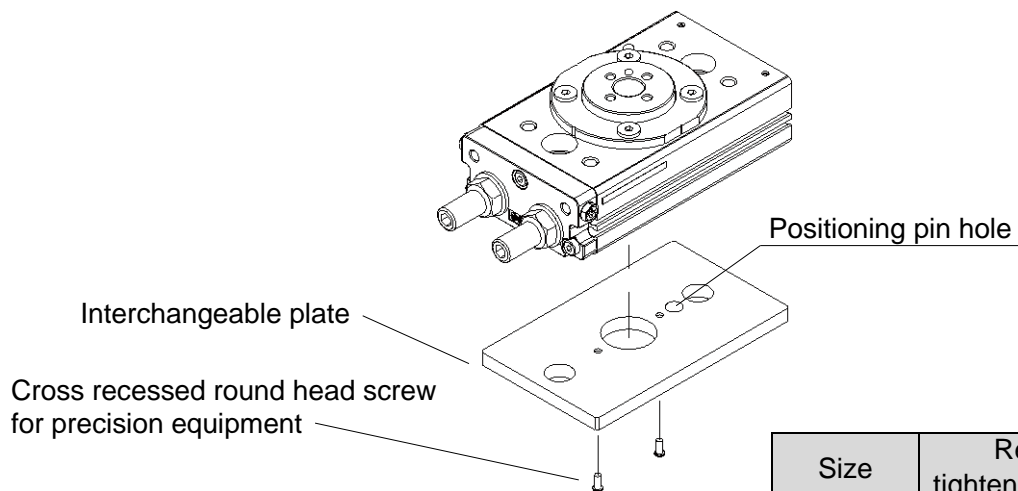


Fig. 30

Size	Recommended tightening torque [N · m]
10 to 50	0.40 to 0.50

- (7) Mount the interchangeable table and parallel pin (already pressed in to the interchangeable table) to the table pinion assembly.  
 \*Made to Order -A, -B only

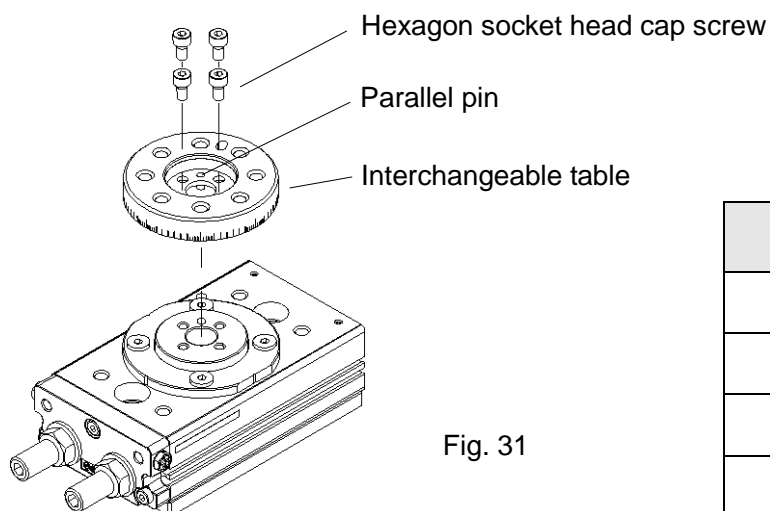


Fig. 31

Size	Recommended tightening torque [N · m]
10	1.10 to 3.10
20	2.90 to 4.90
30	4.90 to 6.90
50	7.40 to 9.80

- (8) Perform operation test after assembling and check external leakage.

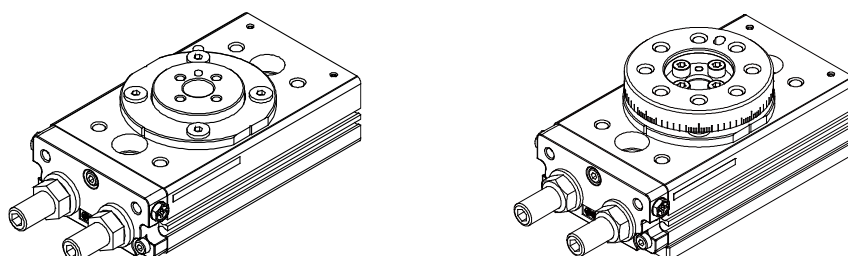


Fig. 32

## Specific product precautions

### Speed Adjustment

#### **Caution**

1. When operating at high speed with a large load weight, a large amount of energy is applied to the actuator and can cause damage. Calculate a correct operation time by referencing the model selection procedure.
2. Supply pressure should be 0.3Mpa or more when the product is used at its maximum operating speed (Min. rotation time of around 0.2s/90°)

### Lubrication

#### **Caution**

1. Use the product without lubrication.

This product is lubricated with grease at the factory, and further lubrication will result in a failure to meet the product's specifications.

### Effective torque

#### **Caution**

1. The effective torque at the end of the rotation is half the effective torque generated during rotation. This is because one of the pistons of the double rack mechanism determines the angle by coming into contact with an adjustment bolt or a shock absorber at the rotation end.

### Rotating angle adjustment

#### **Caution**

1. As a standard feature, the rotary table is equipped with an angle adjustment mechanism (adjustment bolt or shock absorber) that can be used to adjust the rotating angle. Refer to page 27 and 28 for the rotation direction, rotating angle, and rotating angle range examples.
2. Take the complete compression into consideration when the rotation angle of bumper type is adjusted.

he product is operational even when the complete compression force is not reached. When the accuracy at the rotation end is necessary, the methods below are possible.

- 1) To use it with a minimum operating pressure of 0.3 MPa or more.
- 2) To use an external stopper or shock absorber.

The table on the right shows the rotation angle corresponding to the complete compression of the cushion pad allowing the piston to reach the end of stroke.

The values in the table are for reference only.

Size	Angle
10	16°
20	12°
30	12°
50	15°

### Absorption of kinetic energy

#### **Caution**

1. Three types of cushion are available for the product. Cushion pad, bumper and shock absorber.

These are for protecting the product by absorbing the kinetic energy of the workload. Not for a smooth stopping operation. For smooth stopping of the workload, it is necessary to install an appropriately sized shock absorber based on the operating conditions.

## Cushion pad and bumper

### ⚠ Caution

1. The material of the piston is different between products with cushion pads or bumpers and products with shock absorbers.

Since it may damage the piston, do not attach shock absorbers to products with cushion pads or bumpers.

Adjustment bolt assembly

Cushion	Size	Part no.
Cushion pad	10	P391010-3
	20	P391020-3
	30	
	50	P391040-3
Bumper	10	P891010-3
	20	P891020-3
	30	
	50	P891040-3

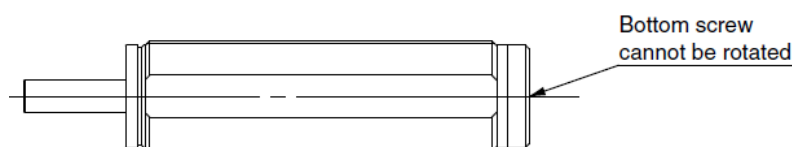
\*Two sets are required for each product.

\*Refer to page 40, for the replacement procedure.

## Shock absorber

### ⚠ Caution

1. Never rotate the bottom screw of the shock absorber.(It is not an adjustment screw.)  
This may cause oil leakage.



### 2. Shock absorbers are consumable parts.

When a decrease in energy absorption capacity is noticed, it must be replaced.

Allowable operation time under the specifications set in this catalog is 1 million.

\* Specified service life (suitable replacement period) is the value at room temperature (20 to 25°C).

The period may vary depending on the temperature and other conditions. In some cases the absorber may need to be replaced before the allowable operation time above.

Size	Shock absorber model
10	RBA0805-X692
20	RBA1006-X692
30	
50	RBA1411-X692

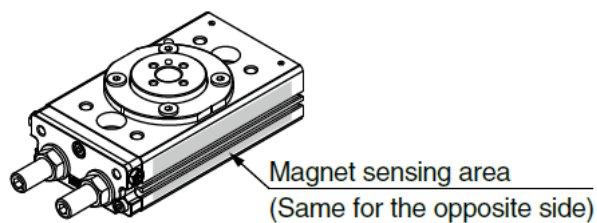
\*Two sets are required for each product.

\* Refer to page 40, for the replacement procedure.

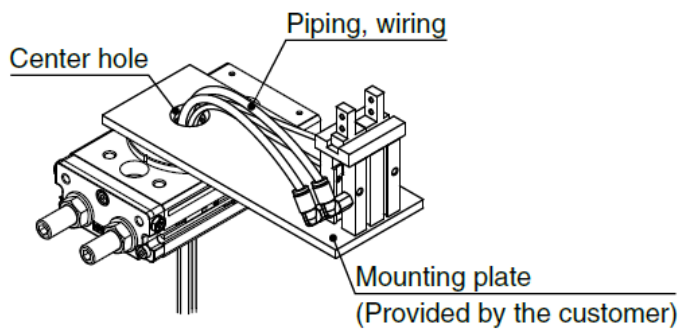
## **⚠ Caution**

### **1. Keep away from objects which are influenced by magnets.**

Since this product has a built-in magnet, do not allow close contact with magnetic disk, cards, or tapes. Data may be erased.



### **2. When using the center hole for piping, take care that the tube O.D., auto switch lead wire, etc., do not contact the mounting plate.**





## Troubleshooting

Problem	Possible cause	Solution
Rotary table does not move	Supply pressure is not applied correctly.	Correctly set the regulator at the supply pressure side.
	The directional switching valve (such as a solenoid valve) does not switch.	Correctly apply a signal to the directional switching valve (such as a solenoid valve).
	Air leakage from piping.	Inspect the piping and stop the leakage.
	The restrictor in the port is clogged.	Clean the restrictor. Take the following countermeasures: (1) Blow air through the piping again. (2) Inspect the air filter.
Operation is not smooth. (stick-slip)	The load has some friction.	Reduce the friction resistance.
	The rotation table and the item used with it are not aligned.	Align the two centers or use a flexible fitting.
	Insufficient output due to a low supply pressure.	To obtain stable operation, adjust the supply pressure to make the load ratio appropriate.
	Speed controller is restricted too much.	Adjust the speed controller so that the rotating marks will be in the adjusting range.
Extreme rotating angle changes.	Internal parts are broken.	Replace the rotary table with the new one. After that, take the measures below. <ul style="list-style-type: none"> <li>• Calculate the kinetic energy applied to the rotary table and adjust the load and rotation speed to make the value within the allowable kinetic energy.</li> <li>• Mount an external stopper or shock absorber to absorb the impact force.</li> </ul> In this case, adjust so that the adjusting bolt does not come into contact with the piston. Set the rotation end with an external stopper.

Problem	Possible cause	Solution
Air leakage from the table	Piston seal is worn out.	The seal parts need to be replaced. Contact SMC.
The pinion gear is broken.	Excessive kinetic energy was applied to the rotary table.	Replace the rotary table with the new one. After that, take the measures below. • Calculate the kinetic energy applied to the rotary table and adjust the load and rotation speed to make the value within the allowable kinetic energy. • Mount an external stopper or shock absorber to absorb the impact force. In this case, adjust so that the adjusting bolt does not come into contact with the piston. Set the rotation end with an external stopper. • Do not apply external torque to the product that exceeds the rated output.
	Excessive external torque was applied to the rotary table.	
Insufficient rotating Angle.	The adjustment bolt for angle adjustment is set at a smaller angle than required.	Set the adjustment bolt correctly.
The auto switch will not operate or operates incorrectly.	The auto switch is mounted in an inappropriate position.	Mount the auto switch in the correct position.
	Effect of an external magnetic field.	Check that there is no strong magnetic field present.
	Trouble with the electrical circuit	Check that there is no trouble with the electrical circuit.
	Trouble with the electrical specification	Check there is no trouble with the electrical specification.

Revision history
C: Initial release
D: Added bumper type variations.

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Note: Specifications are subject to change without prior notice and any obligation on the part of the manufacturer.  
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