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# OPERATION MANUAL

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TITLE : CA2 \* SERIES

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- Read this manual thoroughly before mounting and operation.
- Especially, carefully read the description concerning safety.
- Keep this manual where accessible when necessary.

SMC CORPORATION



# Safety Instructions

These safety instructions are intended to prevent a hazardous situation and/or equipment damage. These instructions indicate the level of potential hazard by a label of "Caution", "Warning" or "Danger". To ensure safety, be sure to observe ISO 4414 Note 1), JIS B 8370 Note 2) and other safety practices.

**⚠ Caution :** Operator error could result in injury or equipment damage.

**⚠ Warning :** Operator error could result in serious injury or loss of life.

**⚠ Danger :** In extreme conditions, there is a possible result of serious injury or loss of life.

Note 1) ISO 4414: Pneumatic fluid power – Recommendations for the application of equipment to transmission and control systems.

Note 2) JIS B 8370: Pneumatic system axiom.

## **⚠ Warning**

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

Since the products specified here are used in various operating conditions, their compatibility for the specific pneumatic system must be based on specifications or after analysis and/or tests to meet your specific requirements.

### **2 Only trained personnel should operate pneumatically operated machinery and equipment.**

Compressed air can be dangerous if an operator is unfamiliar with it. Assembly, handling or repair of pneumatic systems should be performed by trained and experienced operators.

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

1. Inspection and maintenance of machinery/equipment should only be performed after confirmation of safe locked-out control positions.
2. When equipment is to be removed, confirm the safety process as mentioned above. Cut the supply pressure for this equipment and exhaust all residual compressed air in the system.
3. Before machinery/equipment is re-started, take measures to prevent shooting-out of cylinder piston rod, etc. (Bleed air into the system gradually to create back-pressure.)

### **4 Contact SMC if the product is to be used in any of the following conditions:**

1. Conditions and environments beyond the given specifications, or if product is used outdoors.
2. Installation on equipment in conjunction with atomic energy, railway, air navigation, vehicles, medical equipment, food and beverages, recreation equipment, emergency stop circuits, press applications, or safety equipment.
3. An application which has the possibility of having negative effects on people, property, or animals, requiring special safety analysis.



# Actuator Precautions

Be sure to read before handling.

## Precautions on design

### Warning

1. **There is a possibility of dangerous sudden action by air cylinders if sliding parts of machinery are twisted due to external forces, etc.**

In such cases, human injury may occur; e.g., by catching hands or feet in the machinery, or damage to the machinery itself may occur. Therefore, the machine should be designed to avoid such dangers.

2. **A protective cover is recommended to minimize the risk of personal injury.**

If a stationary object and moving parts of a cylinder are in close proximity, personal injury may occur. Design the structure to avoid contact with the human body.

3. **Securely tighten all stationary parts and connected parts so that they will not become loose.**

When a cylinder operates with high frequency or a cylinder is installed where there is a lot of vibration, ensure that all parts remain secure.

4. **A deceleration circuit or shock absorber, etc., may be required.**

When a driven object is operated at high speed or the load is heavy, a cylinder's cushion will not be sufficient to absorb the shock. Install a deceleration circuit to reduce the speed before cushioning, or install an external shock absorber to relieve the shock. In this case, the rigidity of the machinery should also be examined.

5. **Consider a possible drop in operating pressure due to a power outage, etc.**

When a cylinder is used in a clamping mechanism, there is a danger of work dropping if there is a decrease in clamping force due to a drop in circuit pressure caused by a power outage, etc. Therefore, safety equipment should be installed to prevent damage to machinery and human injury. Suspension mechanisms and lifting devices also require consideration for drop prevention.

6. **Consider a possible loss of power source.**

Measures should be taken to protect against human injury and equipment damage in the event that there is a loss of power to equipment controlled by air pressure, electricity or hydraulics, etc.

7. **Design circuitry to prevent sudden lurching of driven objects.**

When a cylinder is driven by an exhaust center type directional control valve or when starting up after residual pressure is exhausted from the circuit, etc., the piston and its driven object will lurch at high speed if pressure is applied to one side of the cylinder because of the absence of air pressure inside the cylinder. Therefore, equipment should be selected and circuits designed to prevent sudden lurching, because there is a danger of human injury and/or damage to equipment when this occurs.

8. **Consider emergency stops.**

Design so that human injury and/or damage to machinery and equipment will not be caused when machinery is stopped by a safety device under abnormal conditions, a power outage or a manual emergency stop.

9. **Consider the action when operation is restarted after an emergency stop or abnormal stop.**

Design the machinery so that human injury or equipment damage will not occur upon restart of operation. When the cylinder has to be reset at the starting position, install manual safety equipment.

## Selection

### Warning

1. **Check the specifications.**

The products advertised in this catalog are designed according to use in industrial compressed air systems. If the products are used in conditions where pressure, temperature, etc., are out of specification, damage and/or malfunction may be caused. Do not use in these conditions.

Consult SMC if you use a fluid other than compressed air.

2. **Intermediate stops.**

When intermediate stopping of a cylinder piston is performed with a 3 position closed center type directional control valve, it is difficult to achieve stopping positions as accurate and minute as with hydraulic pressure, due to the compressibility of air.

Furthermore, since valves and cylinders, etc. are not guaranteed for zero air leakage, it may not be possible to hold a stopped position for an extended period of time. Contact SMC in case it is necessary to hold a stopped position for an extended period.

### Caution

1. **Operate within the limits of the maximum usable stroke.**

Refer to the selection procedures for the type of air cylinder to be used for the maximum usable stroke.

2. **Operate the piston within a range such that collision damage will not occur at the end of the stroke.**

Operate within a range such that damage will not occur when the piston having inertial force stops by striking the cover at the stroke end. Refer to the cylinder type selection procedure for the range within which damage will not occur.

3. **Use a speed controller to adjust the cylinder drive speed, gradually increasing from a low speed to the desired speed setting.**

4. **Provide an intermediate support for cylinders having a long stroke length.**

An intermediate support should be provided in order to prevent damage in cylinders having a long stroke, due to problems such as sagging of the rod, deflection of the tubing, vibration and external load.

## 1. Standard Specifications

Maximum operating pressure ----- 1.0MPa

Proof pressure ----- 1.5Mpa

Ambient and operating temperature----- -10 to 70 °C (No freezing)

Cushion ----- Air cushion for both ends

Action ----- Double acting

## 2. Air supply



Warning

- 2-1. If compressed air includes chemicals, synthetic oils containing organic solvents, salt or corrosive gases etc. It can cause damage or malfunction.
- 2-2. The air to be supplied to the cylinder shall be filtered by SMC AF Series Air Filter and regulated to the specified set pressure by AR Series Regulator.  
Select a filter with nominal filtration rating of 5 $\mu$ m or less.
- 2-3. Lubrication is not required because the cylinder has been lubricated for life at the factory and can be used without any further lubrication.  
However, in the event that will be lubricated, use class 1 the turbine oil (non-additive) ISO VG32. Stopping lubrication later may lead to malfunction due to loss of original lubricant. Therefore, lubrication must be continued once it has been started.

## 3. Cushion



Caution

- 3-1. Cylinder cushions are adjusted properly at the time of shipment. However, readjust the cushion valve on the cover when the cylinder is put into service based upon working load and operating speed.
- 3-2. When the cushion valve is turned clockwise, the cushion contracts and its effectiveness is increased, and when the cushion valve is turned counterclockwise, the cushion expands and its effectiveness is decreased.

- 3-3. If the cushion valve is fully closed throughout operation, the piston may bounce at the stroke end, not move full stroke, or the cushion seal may be damaged due to excessive pressure. Therefore, do not use the cushion cover in such manner.

 Caution

- 3-4. Check that the screw of the cushion valve is screwed in. Although the snap ring is attached, the cushion valve may lurch if the screw is not fitted properly.

 Warning

- 3-5. If the cushion valve is fully opened throughout operation, the cylinder will operate like cylinders without cushion, and impact force will be much larger. If the cylinder is mounted and operated in such conditions as shown in Figure 1, adjust the cylinder in order that the speed  $V$  for the load  $W$  may be less than or equal to the values shown in Table 1. If it can not be kept, the cylinder will be damaged.

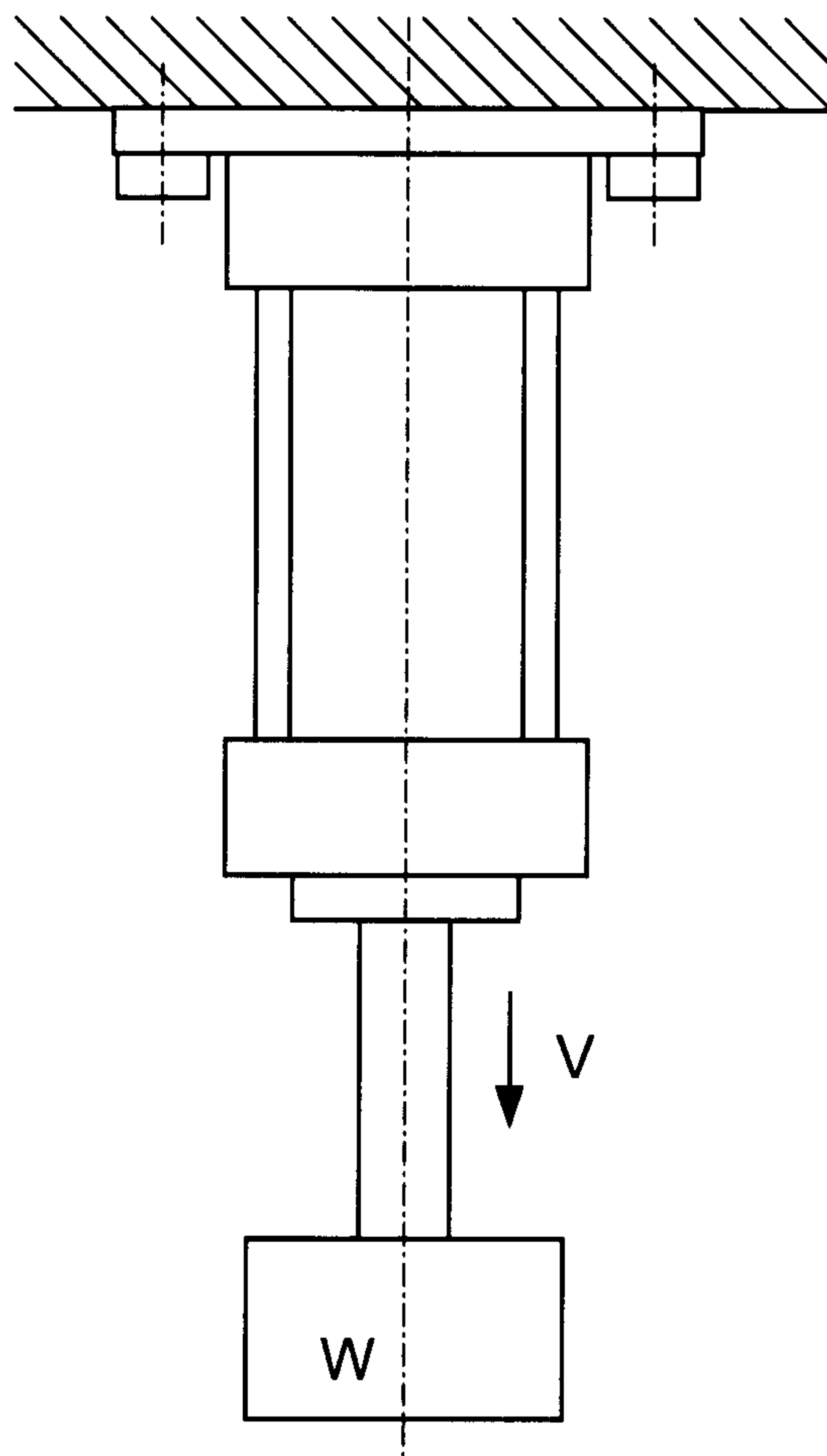


Figure-1

Table 1

Load $W$	Speed $V$ mm/s
80% of theoretical force of 1.0MPa	130
40% of theoretical force of 1.0MPa	190
15% of theoretical force of 1.0MPa	300

#### 4. Speed control

- 4-1. When the cylinder speed is adjusted, install SMC AS Series Speed controllers around the air supply to adjust to the specified speed.
- 4-2. When speed controllers are used for adjusting speed, there are two cases, one is regulating the supply air to the cylinder (meter-in control), and another is regulating the exhaust air from the cylinder (meter-out control). In the former case, cylinder operation will be unstable. Generally, the latter case is applied.

 Warning

- 4-3. The operating speed range of the cylinder should be 50~500mm/s. Avoid operating the cylinder out of the operating speed range. Because not only smooth operation may be unavailable, but also the cylinder may be damaged. If the operating speed range over 500mm/s is required, contact us separately.

#### 5. Direction control

For switching the cylinder operating directions, select applicable solenoid valves from various SMC's solenoid valves, and use them for directional control.

#### 6. Mounting

- 6-1. Lateral load on the cylinder bearing shall be 1/20 or less of the maximum cylinder output force. (See Figure 2 and Table 2).
- 6-2. For the foot type cylinder, the foot has holes for pinning, these can be used for aligning and firmly mounting the cylinder.

 Caution

- 6-3. Be certain to match the rod shaft center with the load and direction of movement when connecting. When not properly matched, problems may arise with the piston rod and the cylinder tube, and damage may be caused due to friction on areas such as the inner tube surface, bushings, rod surface and seals.
- 6-4. When an external guide is used, connect the piston rod end and the load in such a way that there is no interference at any point within the stroke.

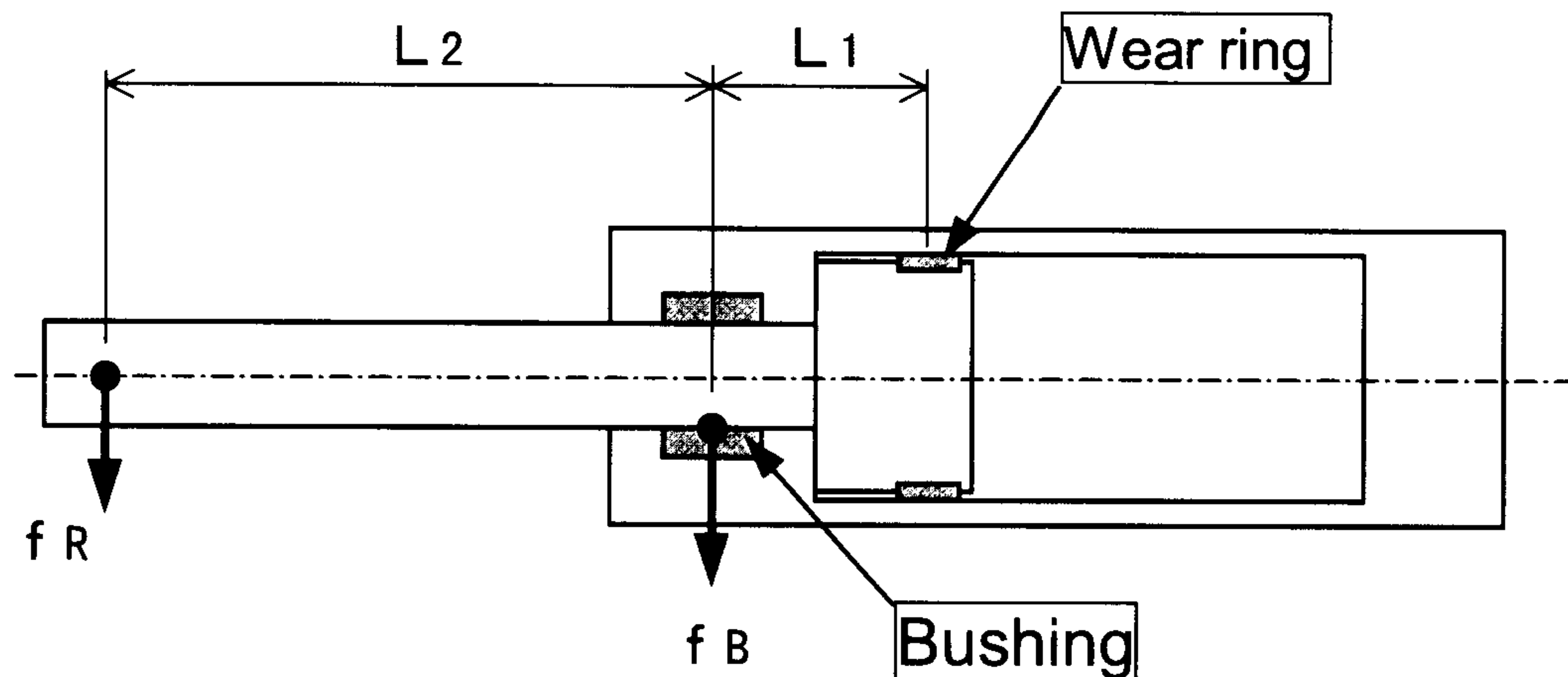


Figure 2 Eccentric load to piston rod

Table 2 Eccentric load to piston rod (kg)

Bore size	L <sub>1</sub>	L <sub>2</sub>	f <sub>B</sub> 1/20 of maximum thrust
40	46	53.5 + Stroke	6.3 kg
50	48	62 + Stroke	9.8 kg
63	51.8	62 + Stroke	15.6 kg
80	64	72.5 + Stroke	25.1 kg
100	67.8	75 + Stroke	39.3 kg

Remarks

$$f_R \leq \frac{L_1}{L_1 + L_2} \cdot f_B = \frac{1}{1 + \frac{L_2}{L_1}} \cdot f_B$$

**!** Caution

6-5. Do not scratch or dent the sliding parts of the cylinder tube or piston rod etc., by striking or grasping them with other objects.

Cylinder bores are manufactured to precise tolerances, so that even a slight deformation may cause faulty operation. Moreover, scratches or dents, etc. in the piston rod may lead to damaged seals and cause air leakage.

6-6. Prevent the seizure of rotating parts.

Prevent the seizure of rotating parts (pins, etc.) by applying grease.

6-7. Do not use until you verify that the equipment can operate properly.

After mounting, repair or modification, etc., connect the air supply and electric power, and then confirm proper mounting by means of appropriate function and leak inspections.

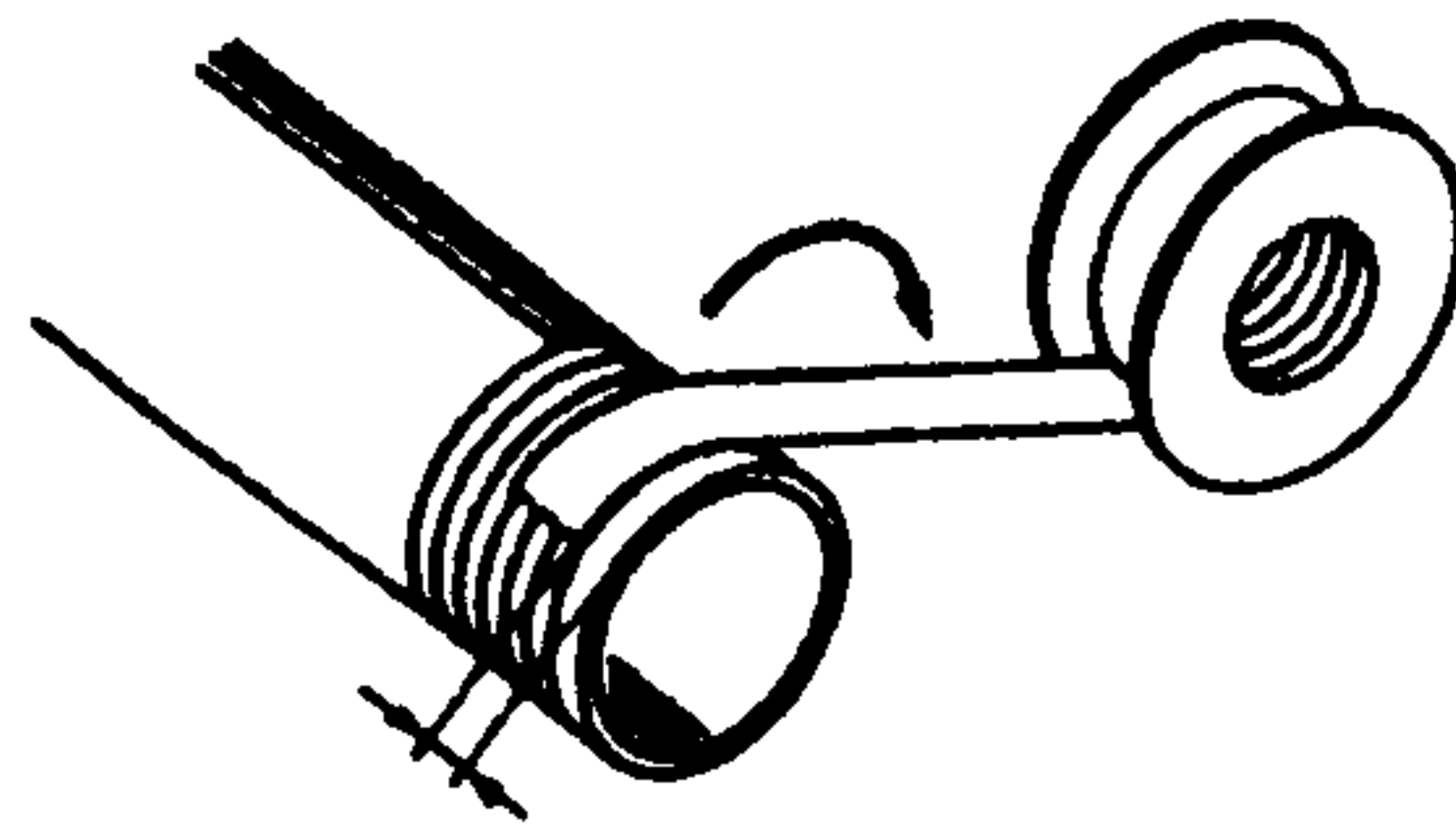
## 7. Piping

### Caution

7-1. Filters can remove dust and scale in the piping. However, it is applicable to upstream of filters, as matter of course, dust and scale of downstream of filters can not be removed. If the piping is connected in this way, dust and scale will enter into solenoid valves and cylinders leading to malfunction or shortening the service life. Therefore, before piping is connected, be sure to thoroughly flush air inside the piping.

7-2. When the cylinder is mounted on site, sufficient measures should be taken not to allow dust in the atmosphere to enter into the piping from the supply port.

7-3. When screwing together pipes and fittings, etc., be certain that cutting chips from the pipe threads and sealing material do not get inside the piping. Also, when pipe tape is used, leave 1.5 to 2 thread ridges exposed at the end of the pipe.



## 8. Basic circuit for the cylinder

Figure 3 shows the basic circuit for operating the cylinder using an air filter, a regulator, a solenoid valve, and speed controllers.

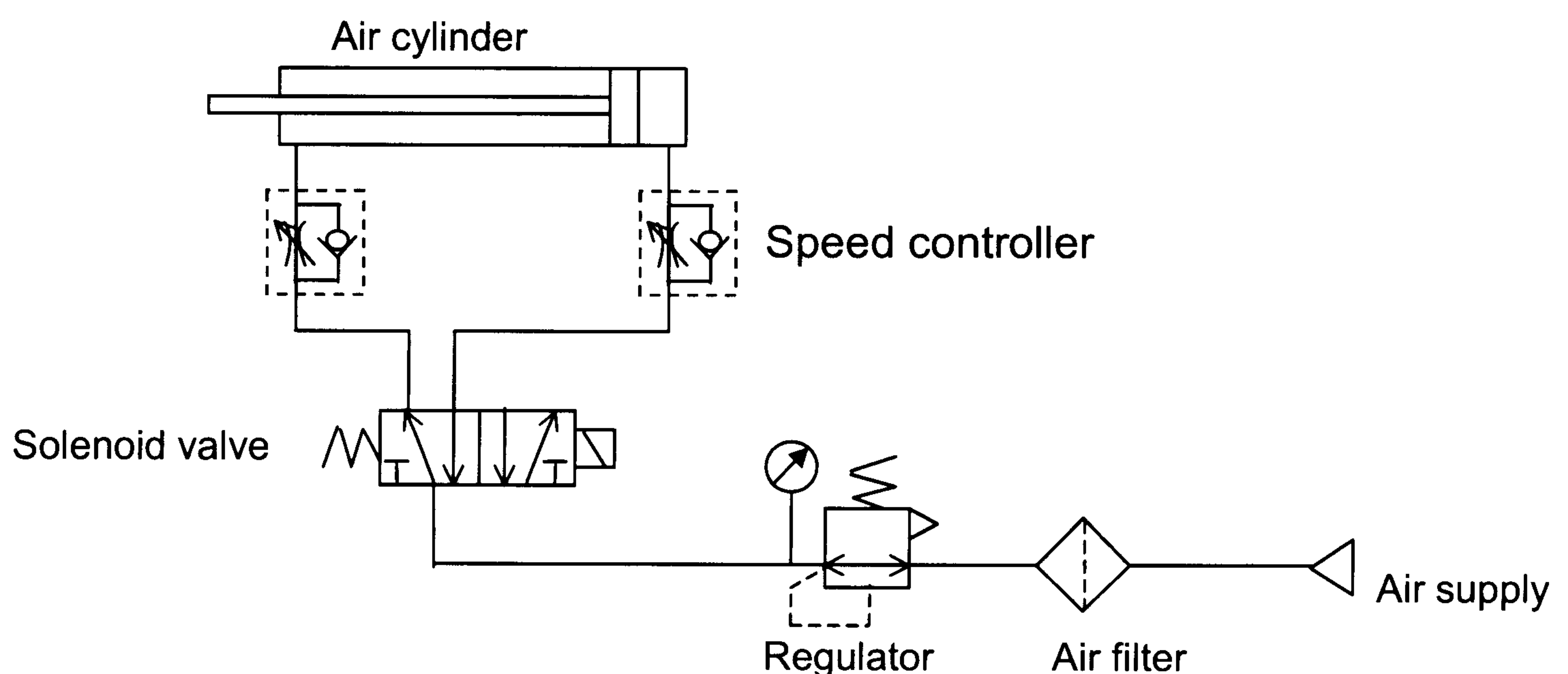


Figure 3 Basic circuit for operating the cylinder



## 9. Operating environment



- 9-1. Do not use in environments where there is a danger of corrosion.
- 9-2. If it is used in an area that is dusty, or in an environment in which water or oil splashes on the cylinder, install a cover over the rod, use the type with a heavy duty scraper (-XC4) or a cylinder with improved water resistance.

## 10. Maintenance



- 10-1. When machinery is serviced, first check measures to prevent dropping of driven objects and run-away of equipment, etc. Then cut off the supply pressure and electric power, and exhaust all compressed air from the system.  
When machinery is restarted, check that operation is normal with actuators in the proper positions.
- 10-2. When the cylinder malfunctions due to air leakage and gouges, replace defective parts referring to Figure 4 and Table 4.
- 10-3. The cylinder can be disassembled by loosening the tie rod nuts. When the tie-rod nuts are dismantled and remounted, use applicable socket wrenches. When the cylinder is assembled, thoroughly check if dust is adhered to the parts or not, completely apply grease to sliding parts such as the tube, the piston, the piston rod, the bushing, and the seals, assemble them without damaging seals etc., and tighten the tie rod nuts in order that tension among 4 tie rods becomes uniform.

Table 3 Applicable socket to tie rod nut and tightening torque

Bore size	Applicable sockets	Tightening torque (N·m)
40	13(M8)	10.8
50	13(M8)	10.8
63	17(M10)	24.5
80	19(M12)	38.2
100	19(M12)	38.2



- 10-4. Remove condensate from air filters regularly.

## 11. Construction

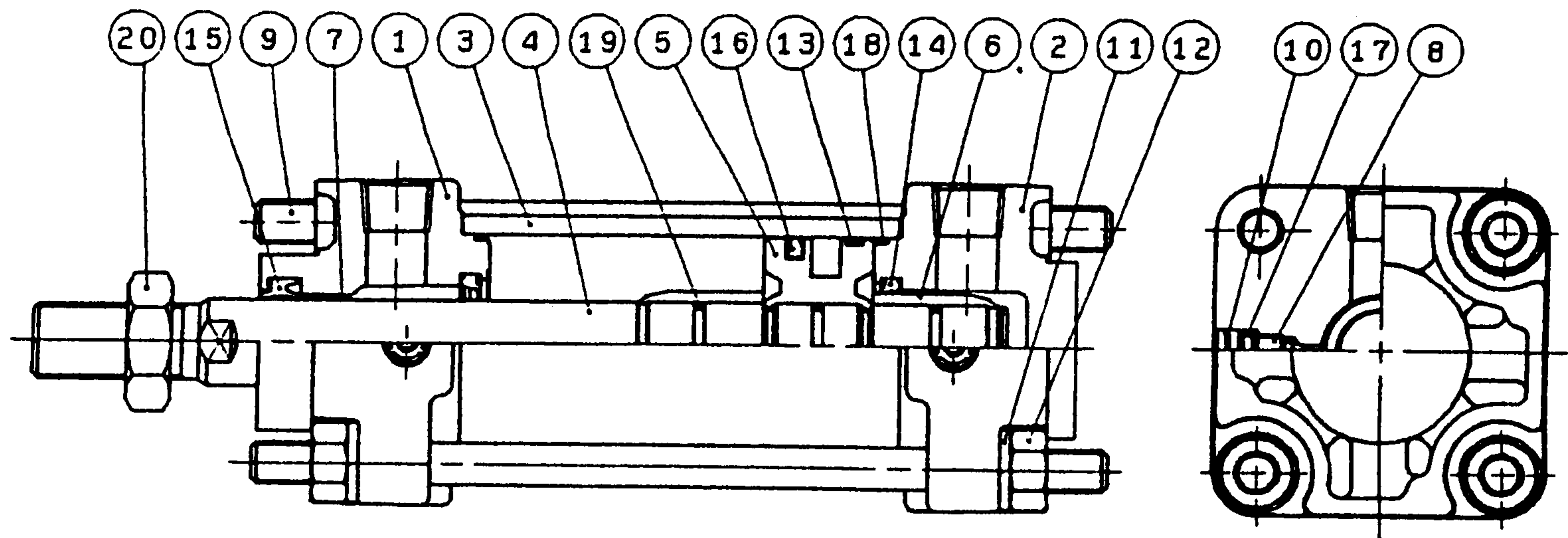


Figure 4

Table 4 Component parts

No.	Description	Material	Quantity	Note
1	Rod cover	Die-cast aluminum	1	Metallic painted
2	Head cover	Die-cast aluminum	1	Metallic painted
3	Cylinder tube	Aluminum alloy	1	Hard anodized
4	Piston rod	Carbon steel	1	Hard chrome plated
5	Piston	Aluminum alloy	1	Chromate
6	Cushion ring	Copper	2	
7	Bushing	Lead bronze casting	1	
8	Cushion valve	Steel wire	2	Nickel plating
9	Tie rod	Carbon steel	4	Corrosion-resistant chromated
10	Snap ring	Spring steel	2	
11	Spring washer	Steel wire	8	Chromate
12	Tie rod nut	Rolled steel	8	Nickel plating
13	Wear ring	Resin	1	
17	Cushion valve seal	NBR	2	
19	Piston gasket	NBR	3	
20	Rod end nut	Rolled steel	1	Nickel plating

Table 5 Seal kits

No.	Description	Material	Quantity	Bore size				
				40	50	63	80	100
14	Cushion seal	Urethane	2	MC-20	MC-25	MC-25	MC-30	MC-35
15	Rod seal	NBR	1	PDU-16Z	PDU-20Z	PDU-20Z	PDU-25Z	PDU-30Z
16	Piston seal		1	PPD-40	PPD-50	PPD-63	PPD-80	PPD-100
18	Cylinder tube gasket		2	MB-40-16AC1248	MB-50-16AC1249	MB-63-16AC1250	MB-80-16AC1251	MB-A0-16AC1252
Seal kit No.				MB40-PS	MB50-PS	MB63-PS	MB80-PS	MB100-PS

Note) Seal kits include grease pack.

## 12. Troubleshooting

Failure	Cause	Countermeasures
The piston rod does not operate smoothly.	Improper alignment at mounting	- Alignment and adjustment at mounting
	Lateral load is applied.	- Provide a proper guide. - Modify the mounting.
	Operated below the lower speed limit	- Remove factors to change load.
	High load factor	- Increase pressure. - Use larger cylinders.
	Speed controllers are meter-in control.	- Change to meter-out control.
	The cushion valve is tightened too much or completely closed.	- Readjust the cushion valve.
Damage/Deformation	Impact force by high speed operation.	- Adjust the cushion. - Lower speed. - Reduce load. - Provide shock absorbing mechanism externally. (Consider using shock absorbers etc.)
	Lateral load is applied.	- Provide a proper guide. - Modify the mounting.