SMC

Document No. : MSUB-OM00002-A

Operation Manual

Rotary Table

Vane type

MSUB1, 3, 7, 20

- Please read this operation manual throughout before installing and operating this product.
- Please read a description on safety instructions with special care.
- Please keep this operation manual with you so that you can read it whenever you need it.

SMC CORPORATION

CONTENTS

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 label of "Caution", "Warning" or "Danger". To ensure safety, be sure to observe ISO4414*1), JIS B 8370*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) ISO4414 : Pneumatic fluid power – Recommendations for the applications 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 her 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 component 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. Then cut the supply pressure for this equipment and exhaust all residual compressed air in the system.
3. Before machinery/equipment is re-started, confirm if appropriate measures have been taken to prevent shooting out of cylinder piston rod.

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, 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.

1. Outlines

This operation manual describes the vane type rotary table.

There are some precautions to operate this product such as load volume(inertia moment), and rotating time. Be sure to use it checking the specifications beforehand.

1-1 Converting SI unit into the traditional unit

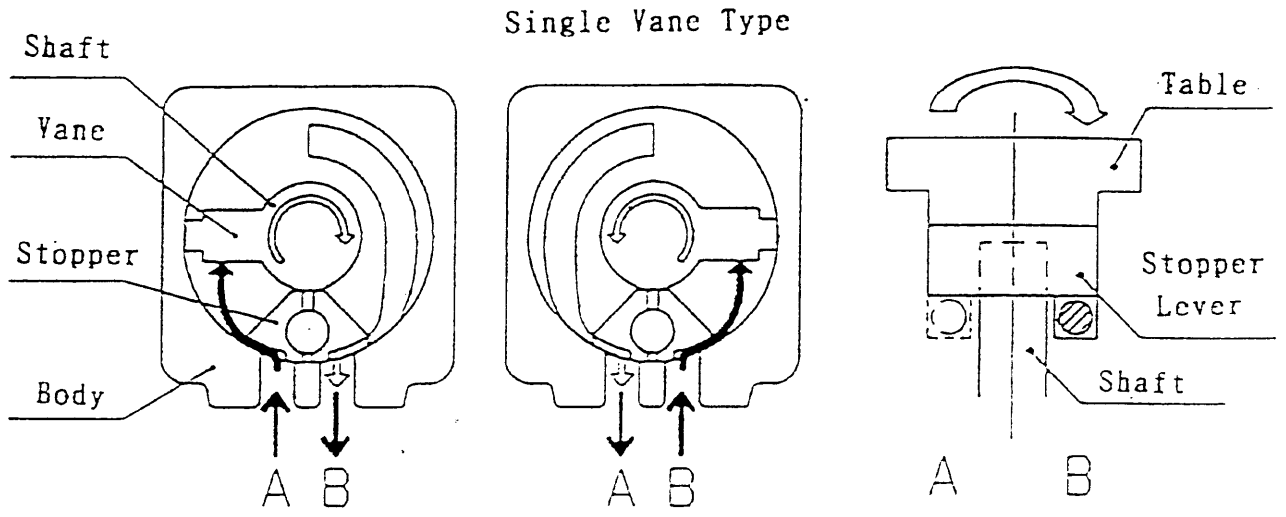
SI unit is used in this operation manual. Converting into the traditional unit is as follows.

Pressure	1MPa	=10.1972 kgf/cm^2	Vibration acceleration	100m/s^2	=10.1972 G
Load	100N	=10.1972 kgf			
Torque	1N·m	=10.1972 kgf·cm	Standard Air Flow	1 ℓ (ANR)=1N ℓ	
Inertia Moment	1kg·m^2	=10.1972 kgf·cm·s			
Kinetic Energy	1J	=10.1972 kgf cm			

Standard Air (Mark : ANR)
Temperature 20℃ {293K}
Absolute pressure 760mmHg {101.3kPa}
Relative Humidity 65% of humid air

1-2 Operating Principles

The positions of the ports A and B mentioned in the figure 1 are those when we look at from the table side.



1. The actuating source consists of the shaft integrated with the vane which rotates inside of the body, and the stopper. The external actuating section consists of the stopper lever integrated with the shaft at the outside, and the table.
2. When the air flows in from the A port, the vane is pushed and torque is generated on the shaft.
3. The air in the outlet chamber is exhausted through B port, and the shaft (including the table) turns clockwise.
4. The ⊘ area of the stopper integrated with the shaft achives the adjusting bolt and stops.
5. When the air flows in from the B port, the shaft turns unticlockwise.

Figure 1

1-3 Specifications

Table 1 Specifications

Model	MSUB 1			MSUB 3			MSUB 7			MSUB 20		
Vane Type	Single Vane		Double Vane	Single Vane		Double Vane	Single Vane		Double Vane	Single Vane		Double Vane
Rotating Angle	90° ±10°	180° ±10°	90° ±5°	90° ±10°	180° ±10°	90° ±5°	90° ±10°	180° ±10°	90° ±5°	90° ±10°	180° ±10°	90° ±5°
Operating Fluid	Air (Non-lub)											
Proof Pressure MPa	1.05									1.5		
Operating Pressure MPa	0.2~0.7			0.15~0.7						0.15~1		
Ambient and Operating Temperature	5~60℃											
Allowable Kinetic Energy J	0.005			0.013			0.032			0.056		
Adjusting Range of Vibrating time sec/90℃	0.07~0.3									0.07~0.3		
Bearing	Ball bearing											
Port Position	Body size or axial											
Port Size Body Size	M3×0.5			M5×0.8						M5×0.8		
Port Size Axial				M3×0.5								
Mounting Type	Only Basic Type											

1-4 Mass

Table 2 Mass

Unit:g

Size	Basic Mass		Switch Unit + 2 switches
	90° type	180° type	
1	145	140	25
3	230	225	30
7	360	355	50
20	510	505	60

1-5 Effective Output

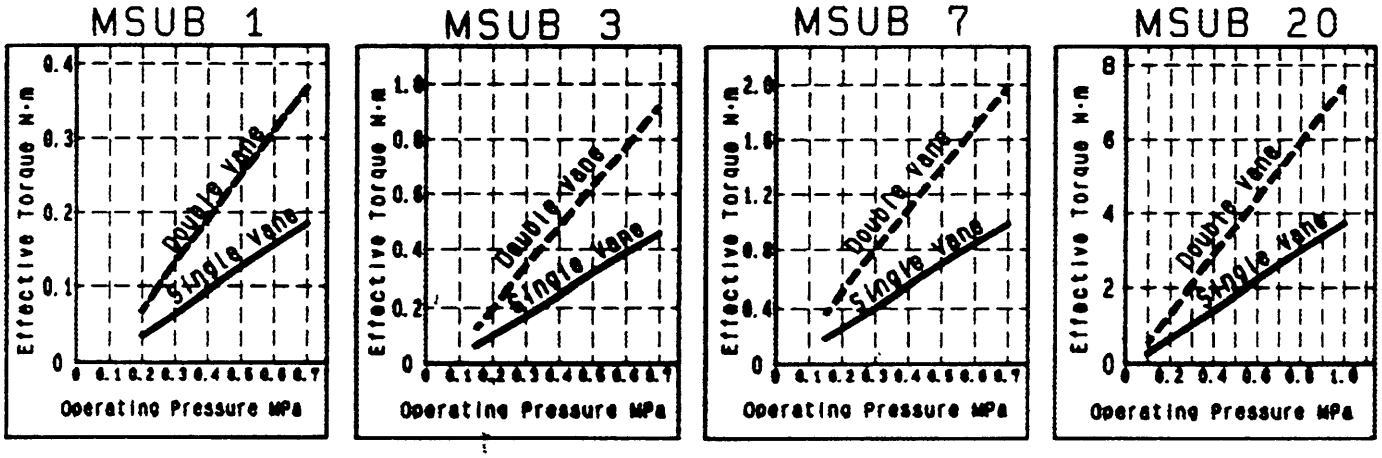


Figure 2 Effective Output

2. Inside Structure and Part Names

MSUB 1,3,7,20-※S

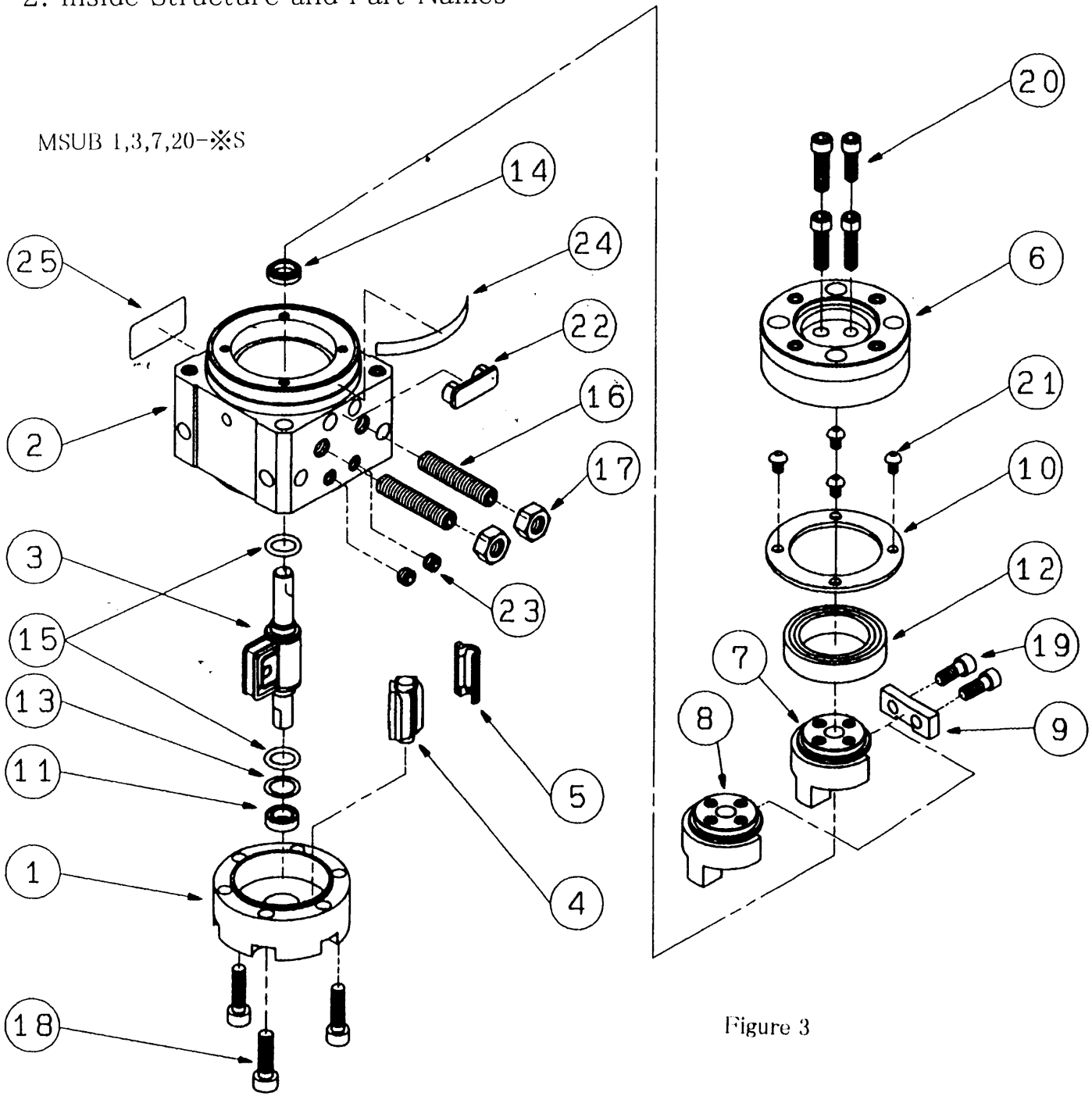


Figure 3

No.	Name	Pes.
25	Name plate	1
24	Plate to indicate rotating direction	1
23	Hexagon socket set screw (For SE type)	2
22	Rubber cap	1
21	Button bolt(with seal)	4
20	Hexagon socket head cap Screw(with seal)	4
19	〃 (with seal)	2
18	〃	3
17	Hexagon nut	2
16	Adjusting bolt	2
15	O ring	2
14	Scraper	1
13	Back-up ring	1
12	Bearing	1
11	〃	1
10	Ring collor	1
9	Lever guide	1
8	Stopper lever(D)< for 90° ->	1
7	〃 (S)< for 180° >	1
6	Table	1
5	Stopper packing	1
4	Stopper	1
3	Vane shaft	1
2	Body(B)	1
1	Body(A)	1

Rotary Table

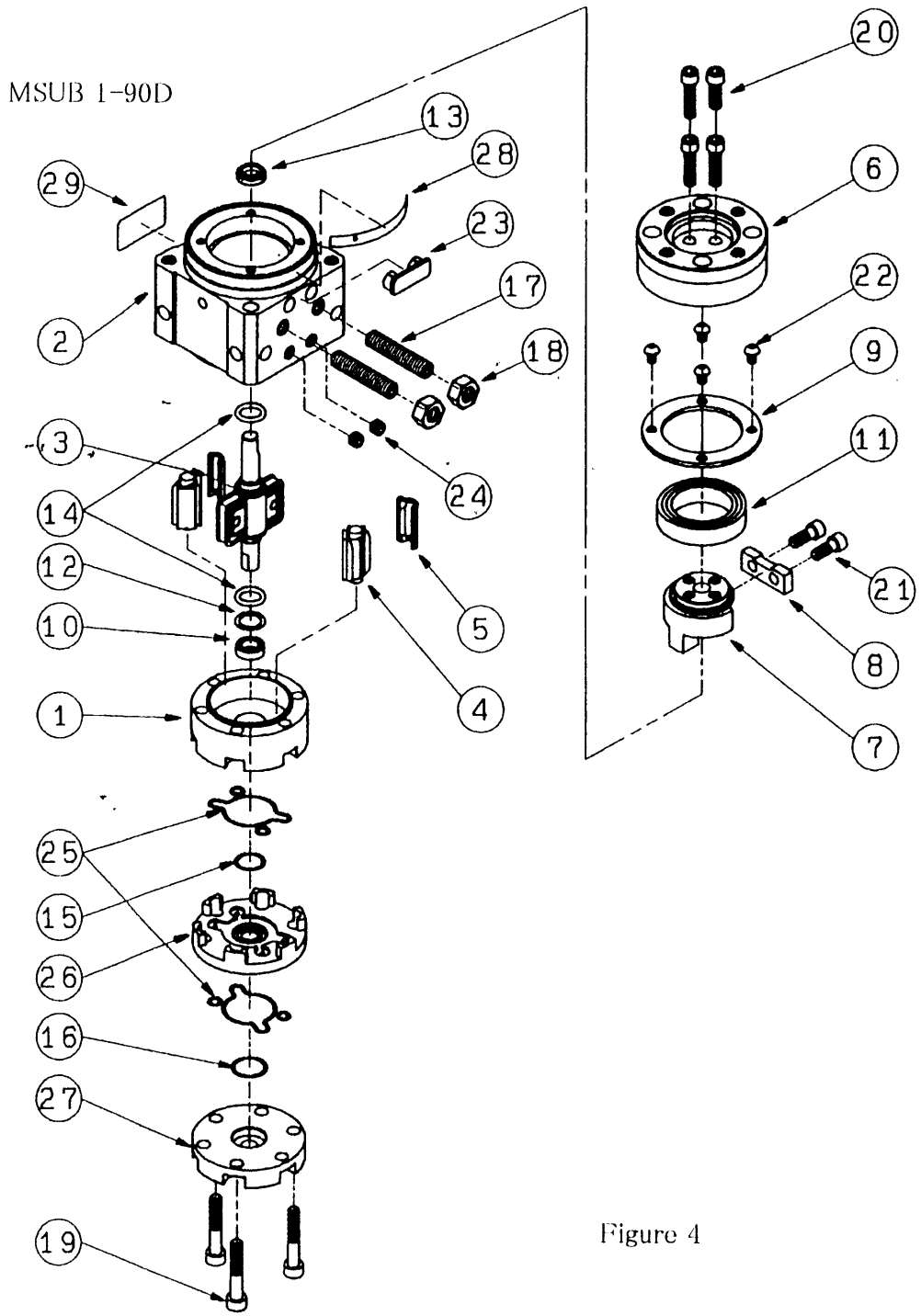


Figure 4

No.	Name	Pes.
29	Name plate	1
28	Plate to indicate rotating direction	1
27	Cover D	1
26	Plate	1
25	Gasket	2
24	Hexagon socket set screw (For SE type)	2
23	Rubber cap	1
22	Button bolt (with seal)	4
21	Hexagon socket head cap screw (with seal)	2
20	〃 (with seal)	4
19	〃	3
18	Hexagon nut	2
17	Adjusting bolt	2
16	O ring	1
15	〃	1
14	〃	2
13	Scraper	1
12	Back-up ring	1
11	Bearing	1
10	〃	1
9	Ring collor	1
8	Lever guide	1
7	Stopper lever (D) <for 90° >	1
6	Table	1
5	Stopper packing	1
4	Stopper	1
3	Vane shaft	1
2	Body(B)	1
1	Body(A)	1

Rotary Table

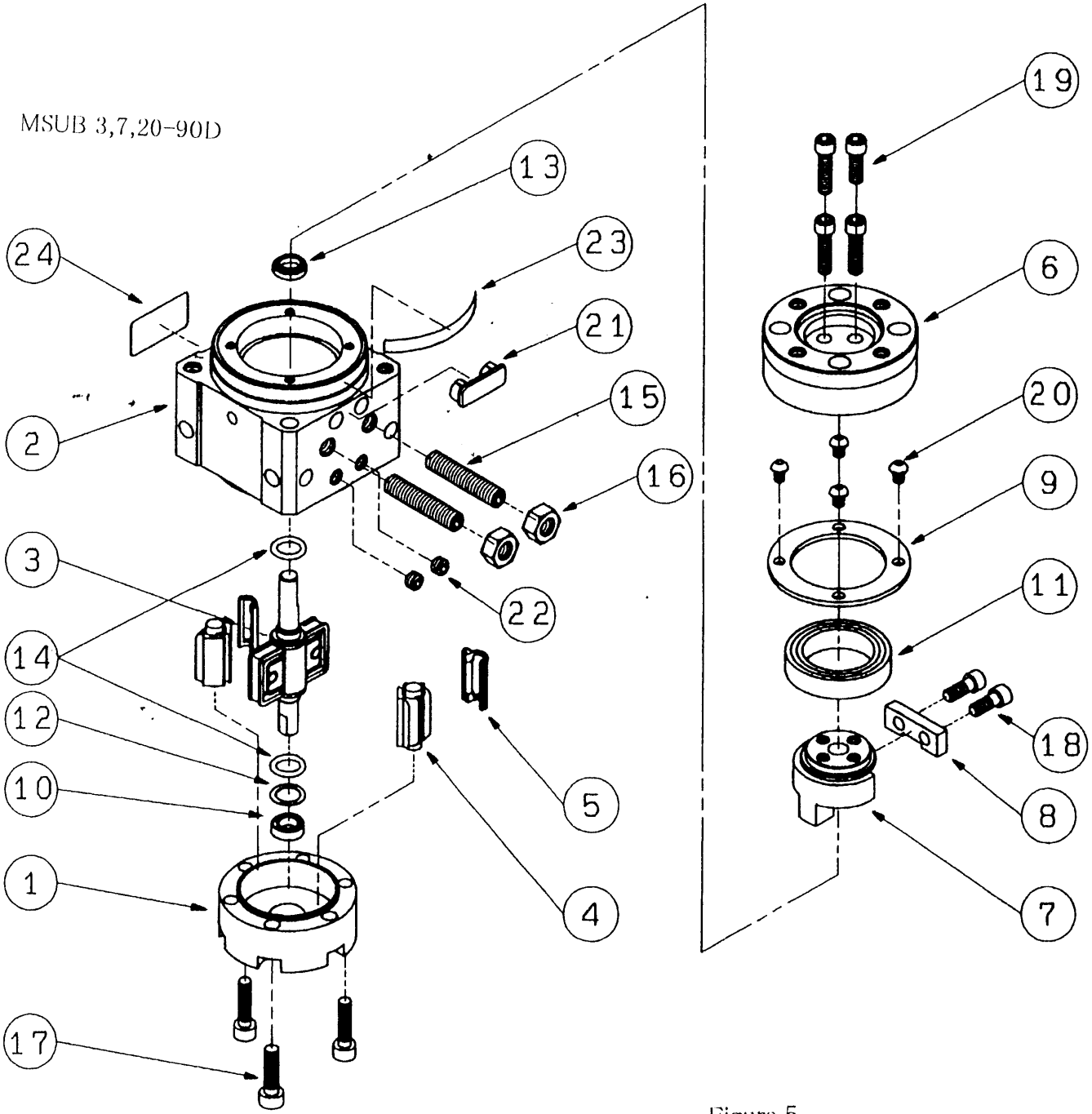


Figure 5

No.	Name	Pes.
24	Name plate	1
23	Plate to indicate rotating direction	1
22	Hexagon socket set screw (For SE type)	2
21	Rubber cap	1
20	Button bolt(with seal)	4
19	Hexagon socket head cap Screw(with seal)	4
18	〃 (with seal)	2
17	〃	3
16	Hexagon nut	2
15	Adjusting bolt	2
14	O ring	2
13	Scraper	1
12	Back-up ring	1
11	Bearing	1
10	〃	1
9	Ring collor	1
8	Lever guide	1
7	Stopper lever(D)<for 90° >	1
6	Table	1
5	Stopper packing	1
4	Stopper	1
3	Vane shaft	1
2	Body(B)	1
1	Body(A)	1

Rotary Table

3.Basic Circuit to Operate Rotary Table

3-1 Construction of Circuit

The figure 4 shows the basic circuit to operate the rotary table using an air filter, a regulator, a solenoid valve, and a speed controller.

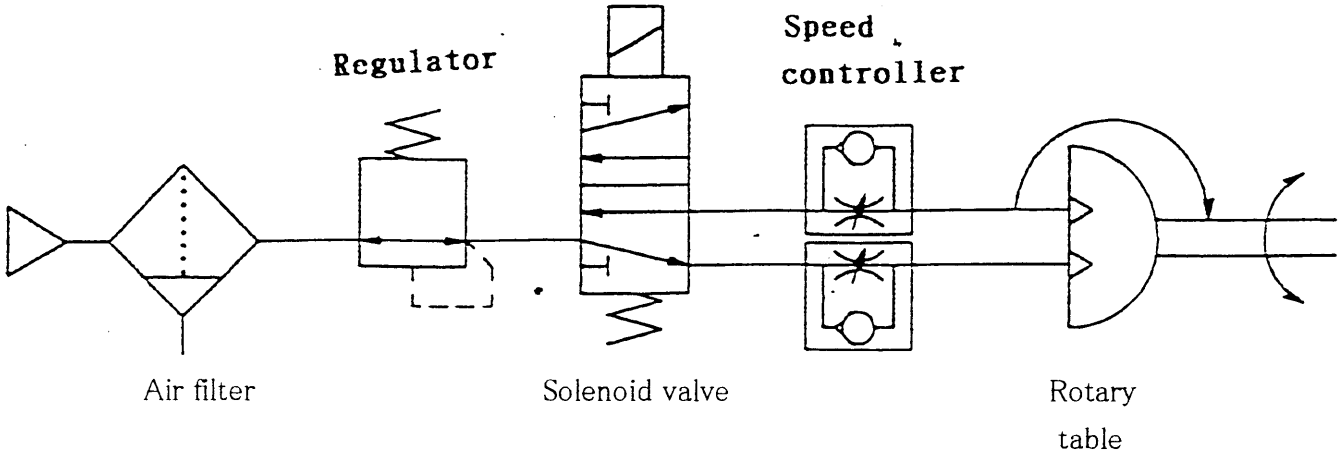


Figure 6 Basic Circuit

3-2 Recommended Equipment

Table 3 Recommended Equipment

Devices \ Type			MSUB 1	MSUB 3	MSUB 7	MSUB 20
Solenoid Valve Elastic Seal (Only VZ2000 is metal seal.)	VZ1000 Series		Cv=0.05			
	VZ2000 Series				M5 Cv=0.14~0.16	
	VZ3000 Series				Cv=0.2	
	VJ3000 Series		M3 Cv=0.05		M5 Cv=0.1	
	VJ5000 Series					M5 Cv=0.2
	VF1000 Series			M5 Cv=0.1		
Speed Controller	In-line Type		AS1000~M5			
	Direct Connection Type		AS1200			
	With One-touch fitting	In-line Type	AS1001F AS2001F			
		Direct Connection Type	AS1201F-M5 AS1301F-M5			
Tube			φ4/φ2.5			

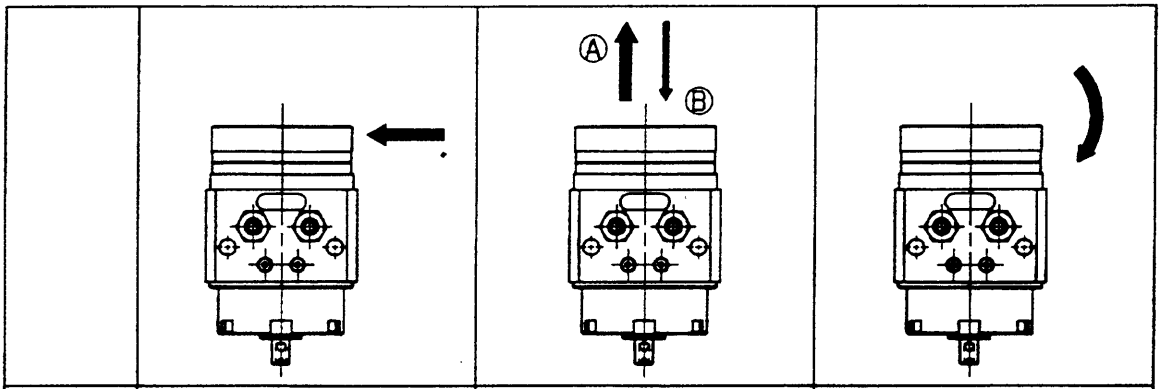
4. Setting

4-1 Limitation of load on Table

Set both load and moment on the table less than the allowable level mentioned in the table 4.

(If load and moment exceed the allowable level, it will affect life of the table because of backlash, deterioration of accuracy etc...)

Table 4 Allowable load



Size	Allowabl Radial Load(N)	Allowable Thrust Load(N)		Allowable Moment(N·m)
1	20	Ⓐ 15	Ⓑ 10	0.3
3	40	30	15	0.7
7	50	60	30	0.9
20	60	80	40	2.9

4-2 Rotating Range of Table

By adjusting the adjusting bolts (A) and (B), the rotating angle is controlled as shown in the figure 5.

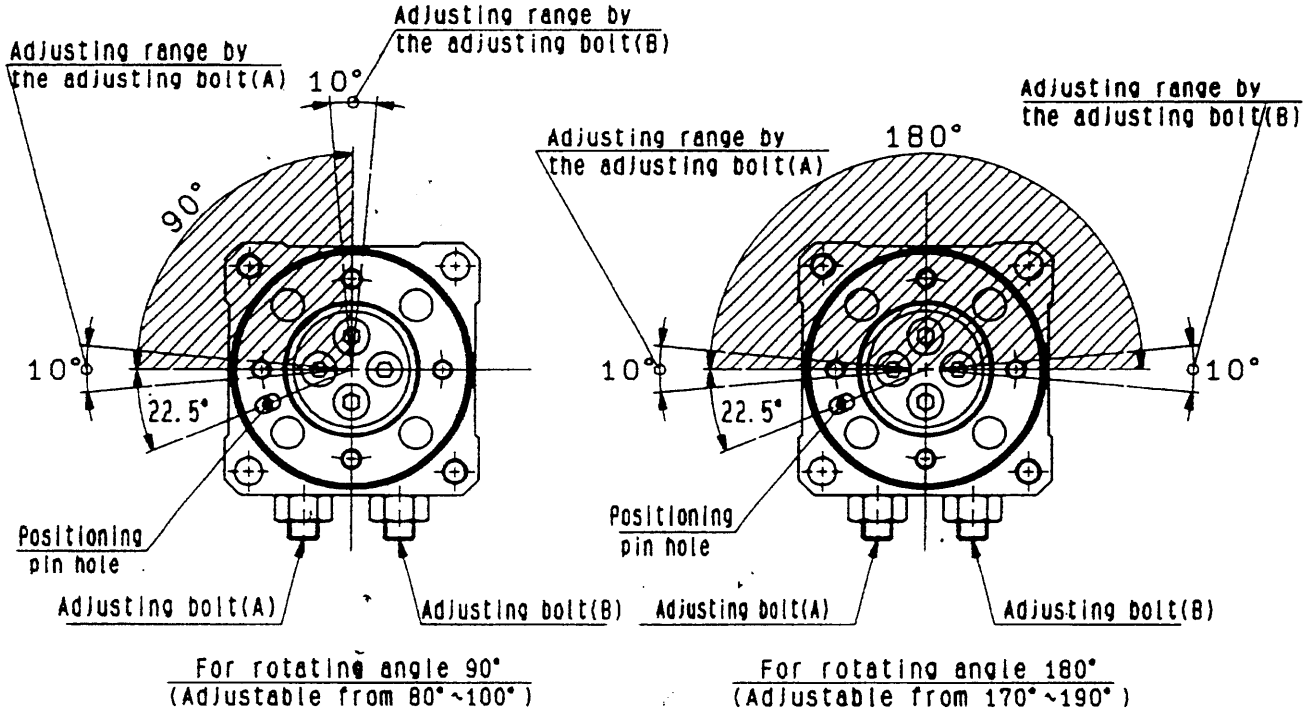


Figure 7

4-3 How to calculate load condition

Example : MSUB 7	Allowable thrust	··30 N
	Allowable momoen	··0.9 Nm

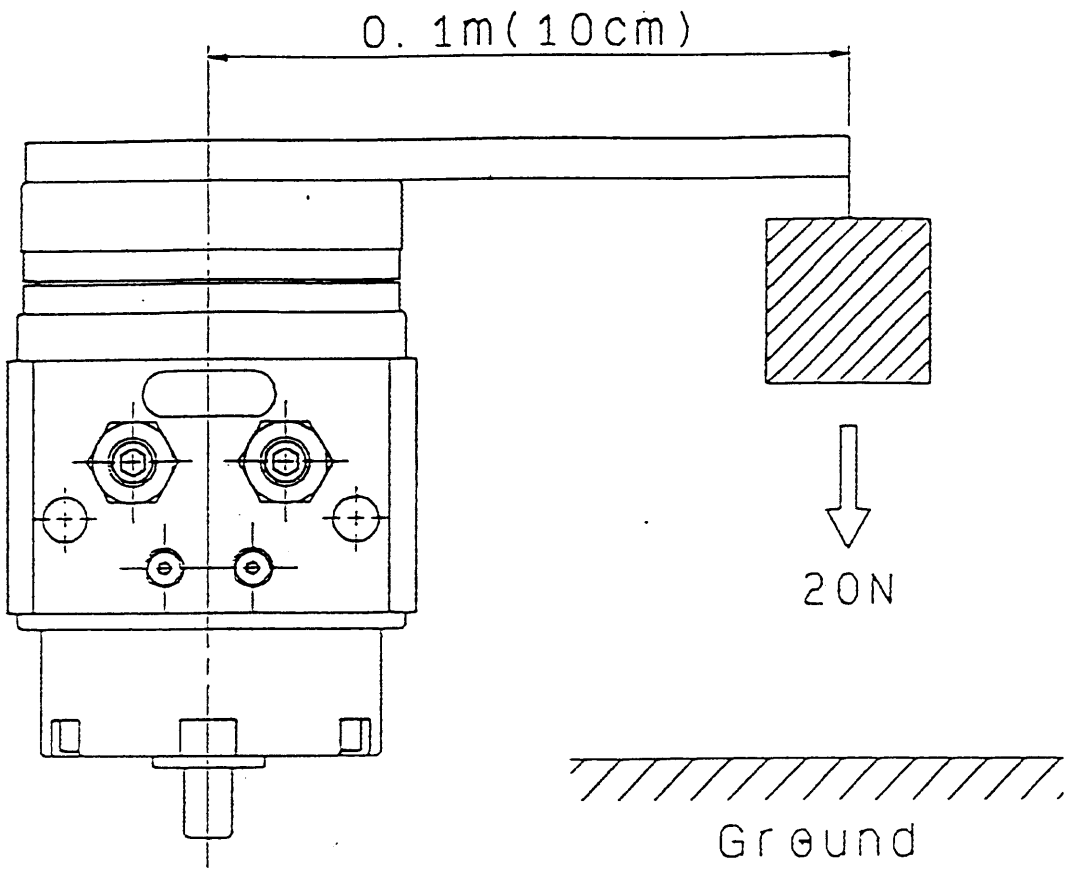


Figure 8

As for the above mentioned load conditions, in the case of selecting MSUB7,the thrust load 20N is within the allowable level, 30N, on the other hand, the moment is 20N × 0.1m = 2N·m, it exceeds the allowable moment, 0.9N·m, and it can not be used. In this case, something such as using a larger sized model should be considered.

4-4 Using Body as Frange

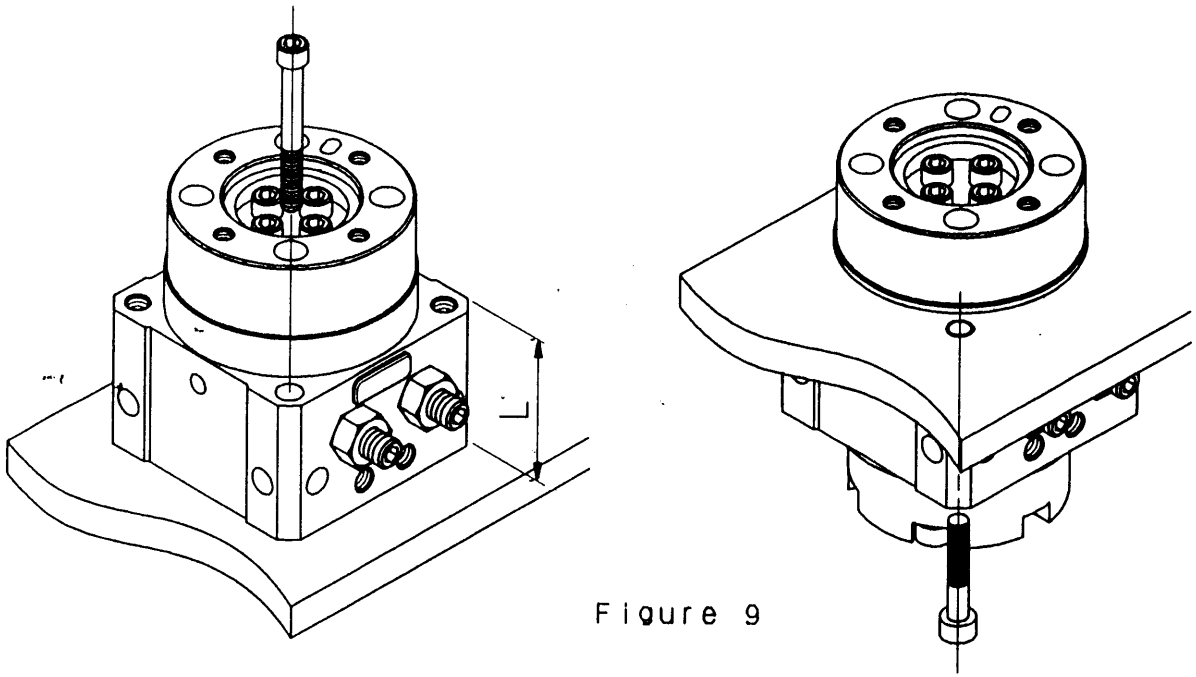


Figure 9

Table 5 Axial mounting dimension

Size	L	Bolt
1	24	M4
3	26	M4
7	30.5	M5
20	34	M6

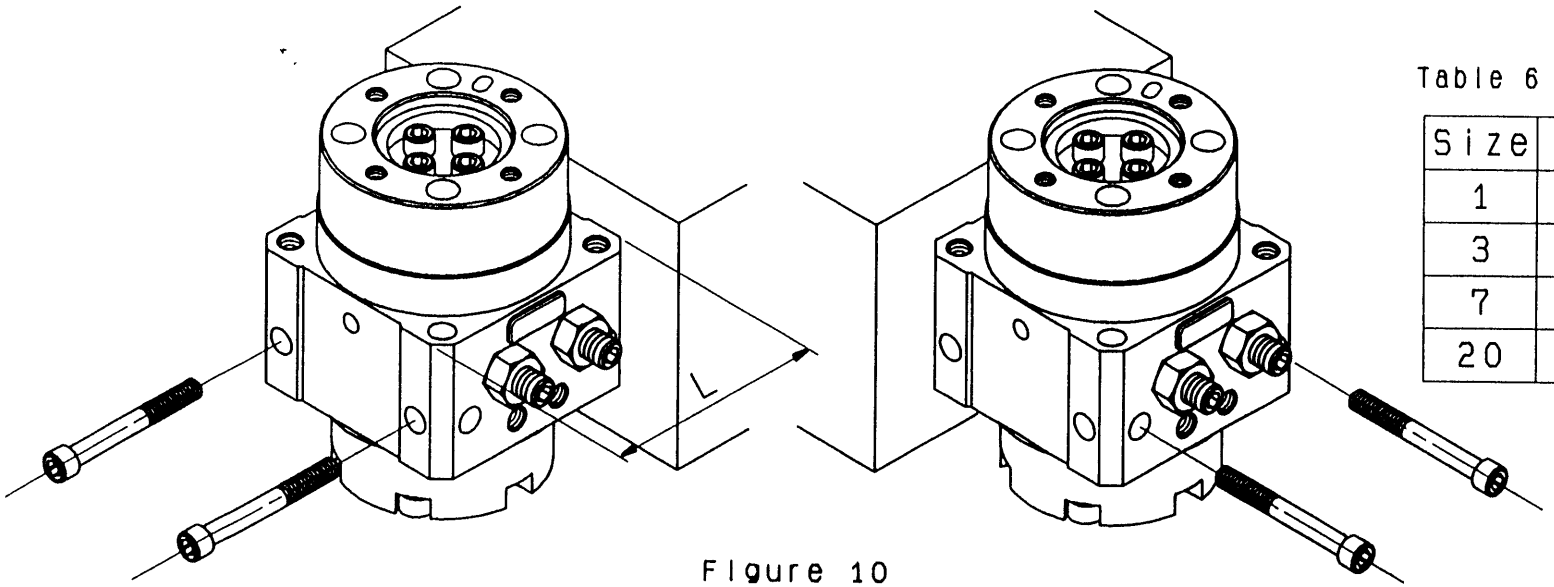


Figure 10

Table 6 Lateral mounting dimension

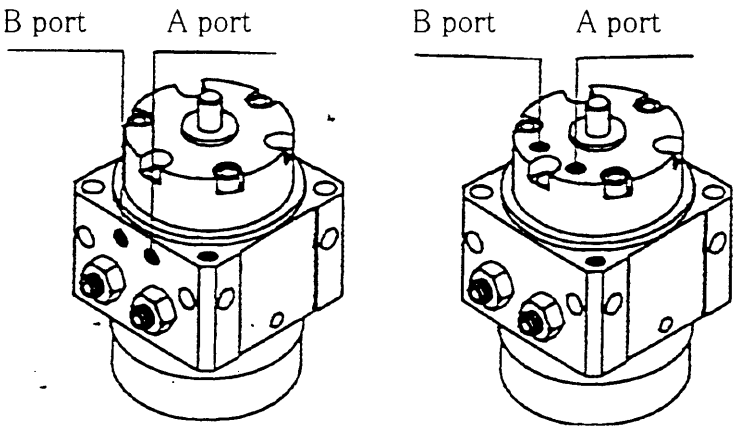
Size	L	Bolt
1	38	M4
3	44	M4
7	50	M5
20	56	M6

4-5 Piping

Positions and size of piping ports are shown in the figure 11 and the table 7.

Table 7 port Size

Size	Port size	
	Body Size	Axial
1	M3×0.5	
2	M5×0.8	M3×0.5
7	M5×0.8	
20	M5×0.8	



Ports at the body side

Port at the axial direction

Figure 11 Port Position

Perform as follows in the case of piping.

a)As for dust and scales inside pipes, although those in front of a filter can be removed by the filter, those at the rear can't, and they come into inside of solenoid valves and cylinders. As a result, malfunction might occure or life might be shortened. Be sure to flush the inside of pipes and connect them.

b)When pipes and fittings are screwed in, be careful not to mix chips of piping screws and sealing materials. When seal tape is used, wind it leaving 1.5~2.0 grooves at the thread section.

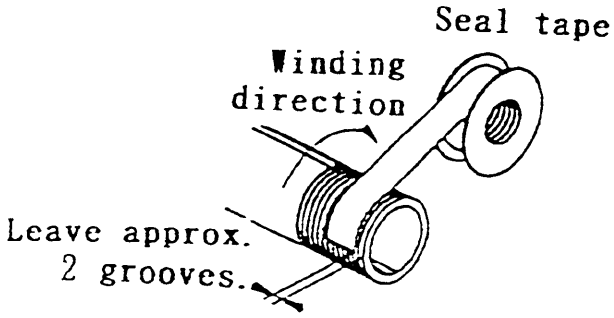


Figure 12 How to wind seal tape

4-6 Operating Air

Clean the air by filtration, and supply it to the rotary table.

Since MSU series can be used without lubrication, a lubricator is not necessary.

If the poduct is used lubricating because of the pneumatic circuit, do not stop inbricating in progress. Lubricate with class 1 turbine oil (ISO VG32).

5.Setting of Rotating Time

Even if generating torque of the rotary table is small, the table and inside parts might be damaged because of inertia force of load. When the rotary table is operated, it is necessary to set rotating time after calculating inertia moment of load and kinetic energy.

5-1 Inertia Moment

When an object is actuated by a rotary table, inertia force is generated, and when it is stopped at the stroke end, strong impact force(kinetic energy) works on the rotary table because of inertia force on the object.

Kinetic energy at that moment is calculated by the following formula.

$$E = 1/2 \cdot (I + Io) \cdot \omega^2$$

E : Kinetic energy	J
I : Inertia moment	$kg \cdot m^2$
Io : Table Inertia moment	$kg \cdot m^2$
ω : Augular velocity	rad/s

Since allowable kinetic energy for the rotary table is limited, the limit of rotating time is found by calculating inertia moment.

Inertia moment is a value to express difficulty of rotating an object, in other words, difficulty stopping a rotating object, and it depends on size, shape and mass of an object.

Basic formula of inertia moment is:

$I = m \cdot r^2$ m : Mass kg

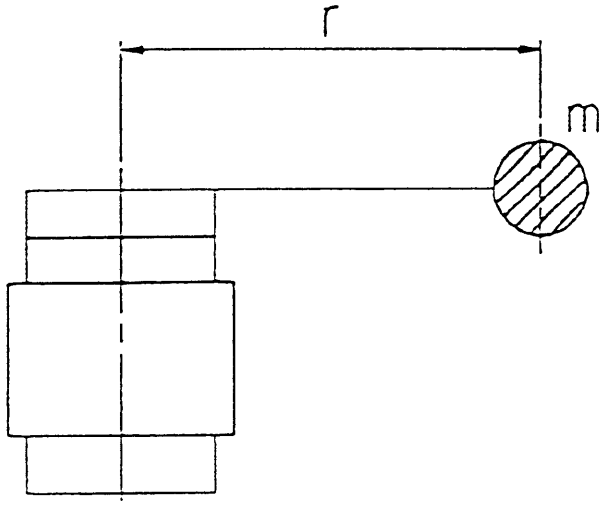
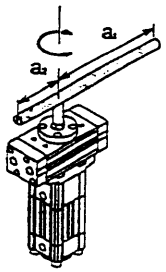


Figure 13

This is the inertia moment of an object, which is 'r' distance away from the axis of rotation, for the axis of rotation. The formulae to calculate inertia moment are different depending on shape of objects. The next page shows how to calculate inertia moment in each shape.

Calculating a Moment of Inertia I (I: Moment of inertia kg•m² m: Weight of load kg)

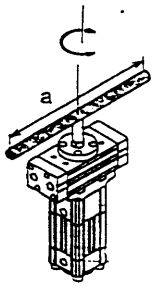
❶ Thin rod



Rotation of pivot:
Passes through one end perpendicular to the rod.

$$I=m_1 \cdot \frac{a_1^2}{3} + m_2 \cdot \frac{a_2^2}{3}$$

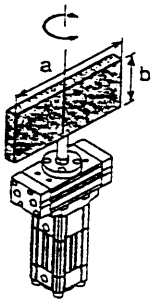
❷ Thin rod



Position of pivot:
Passes through the center of gravity perpendicular to the rod.

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

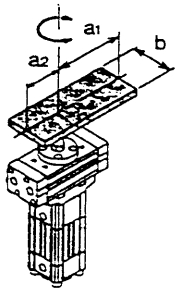
❸ Thin rectangular plate (rectangular parallel piped)



Position of pivot:
Passes through the center of gravity, parallel to side b.

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

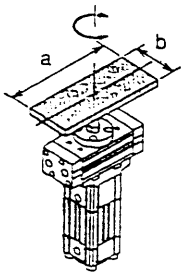
❹ Thin rectangular plate (rectangular parallel piped)



Position of pivot:
Passes through one end perpendicular to the plate.

$$I=m_1 \cdot \frac{4a_1^2+b^2}{12} + m_2 \cdot \frac{4a_2^2+b^2}{12}$$

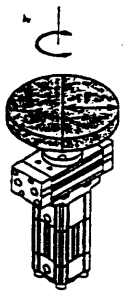
❺ Thin rectangular plate (rectangular parallel piped)



Position of pivot: Passes through the center of gravity perpendicular to the plate. (Similar to thick rectangular plate)

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

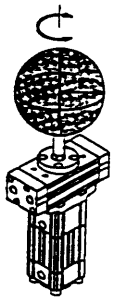
❻ Column (inclusive of thin disk)



Position of pivot:
Axis

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

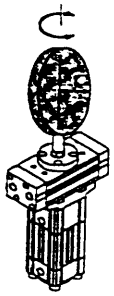
❼ Solid globe



Position of pivot:
Diameter

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

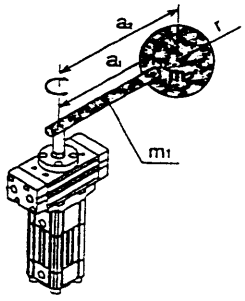
❽ Thin disk



Position of pivot:
Diameter

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

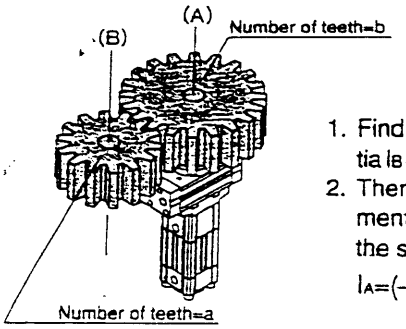
❾ If load is in the end of lever



$$I=m_1 \cdot \frac{a_1^2}{3} + m_2 \cdot a_2^2 + K$$

(Example)
When W_2 is spherical,
$K=m_2 \cdot \frac{2r^2}{5}$ according to ❼.

❿ Propagation of gear



1. Find the moment of inertia I_B around the shaft (B).
2. Then replace the moment of inertia I_B around the shaft (A) by I_A.

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

5-2 Kinetic Energy

Allowable kinetic energy of the rotary table is mentioned in the table 8. Since the rotary table is small volume, it may reach stroke end while accelerating.

Terminal angular velocity ω in that case is given below.

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

θ : Rotating angle r a d

t : Rotating time s

Table 8 Allowable Kinetic Energy

Size	Allowable Kinetic Energy
1	0.005 J
3	0.013 J
7	0.032 J
20	0.056 J

Kinetic energy E is given as follows.

$$E = 1/2\ (I + Io)\ \omega^2$$

Then rotating time of the rotary table t, is as follows.

$$T \geq \sqrt{\frac{2 \cdot I \cdot \theta^2}{E}}$$

E: Allowable kinetic energy J

I : Inertial moment k g· m^2

Io : Table moment k g· m^2

θ : Rotating angle r a d

Table 9 Table moment

Size	Io
MSUB 1	2.5×10^{-6}
3	6.2×10^{-6}
7	16.0×10^{-6}
20	28.0×10^{-6}

In isometoric accelerated motion, angular velocity ω, and second of arc θ in t seconds are calculated as follows.

$\omega = \dot{\omega} \times t$

$\theta = \int \dot{\omega}\ t\ dt = \frac{1}{2}\dot{\omega}\ t^2 + C$ C is integral factor.

Second of arc θ at t=0 is θ=0, then integral factor is C=0.

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

Therefore,

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

5-3 External Stopper

When kinetic energy generated by load exceeds allowable kinetic energy of an actuator, a shock absorbing system should be equipped to absorb inertia force.

Position of Mounting External Stopper

As a shaft or a bearing may be damaged depending on the position of mounting an external stopper, mount it on the mass point of load or on the place away from an actuator.

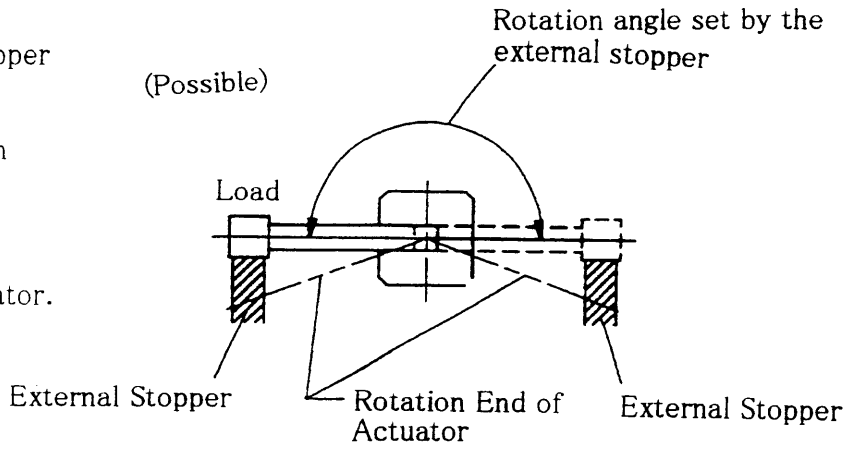


Figure 14 Position to Mount External Stopper(Correct)

When an external stopper is equipped near an actuator, as the external stopper becomes the fulcrum, and inertia force of load is added as bending moment, it affects the product.

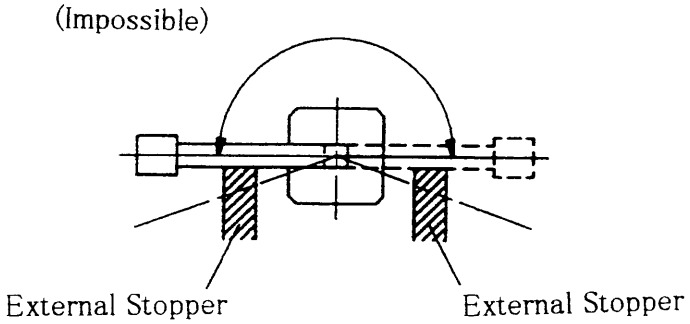


Figure 15 Position of Mounting External Stopper(Wrong)

Precautions to Use External Stopper

Since the angle adjusting system is equipped to the rotary table MSU series, Set adjusting bolt at the position where it does not touch a stopper lever.

6. Rotary Table with Auto Switch

Rotary Table with Auto Switch is the product which mounts an auto switch to detect rotating position of the table on the outside of the body.

6-1 Auto Switch Specifications

Table10 Applicable Auto Switch

Applicable series	Auto switch model		Lead wire entry	Indicator light
MDSUB1 MDSUB3	Reed switch	D-90, 90A	Grommet/ 2 wire	-
		D-97, 93A		Available
	Solid state switch	D-S99, S99V	Grommet / 3 wire	
		D-S9P,S9PV	Grommet / 3 wire PNP	
		D-T99,T99V	Grommet / 2 wire	
MDSUB7 MDSUB20	Reed switch	D-R73	Grommet/ 2 wire	Available
		D-R80	Connector/ 2 wire	-
	Solid state switch	D-S79	Grommet / 3 wire	Available
		D-S7P	Grommet /3 wire PNP	
		D-T79	Grommet / 2 wire Connector/ 2 wire	

Table 11 Auto Switch Part Number / Specifications

Model	Auto switch model		Applicable load	Load voltage	Max. load current and load current range
	Right hand mounting	Left hand mounting			
D-9	D-90		Relay, IC circuit, PLC	24V AC DC or less	50 mA
	D-90A			24V AC DC or less	50 mA
				100V AC DC	20 mA
	D-97		Relay, PLC	24V DC	5~40mA
	D-93A			24V DC	5~40mA
				100V AC	5~20mA
D-R7	D-R731	D-R732	Relay, PLC	24V DC	5~40mA
				100V AC	5~20mA
D-R8	D-R801	D-R802	Relay, IC circuit, PLC	24V AC DC or less	50mA
				48V AC DC	40mA
				100V AC DC	20mA
D-S7	D-S791	D-S792	Relay, IC circuit, PLC	28V AC DC or less	40mA or less
D-S7P	D-S7P1	D-S7P2		-	80mA or less
D-S9	D-S991 D-S99V1	D-S992 D-S99V2	Relay, IC circuit, PLC	28V DC or less	40mA or less
D-S9P	D-9P1 D-S9PV1	D-29P2 D-S9PV2		-	80mA or less
D-7T	D-T791	D-T792	24V DC relay, PLC	24V DC	5~150mA
D-T9	D-T991 D-T99V1	D-T992 D-T99V2	24V DC relay, PLC	24V DC	5~40mA

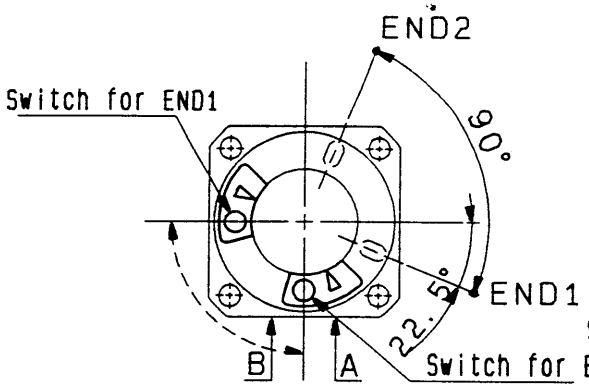
Response time: 1.2 ms <Reed switch>, 1ms or less <Solid state switch>

Operating pressure range: 5~60°C Lead wire length: 0.5m (Standard)

Shock resistance: 300m/S^2 <Reed switch>, 1000m/S^2 <Solid state switch>

6-2 Rotating Range of Pin Hole for Positioning Table Surface and Mounting Position of Auto Switch

MSUB1·3 90°



180°

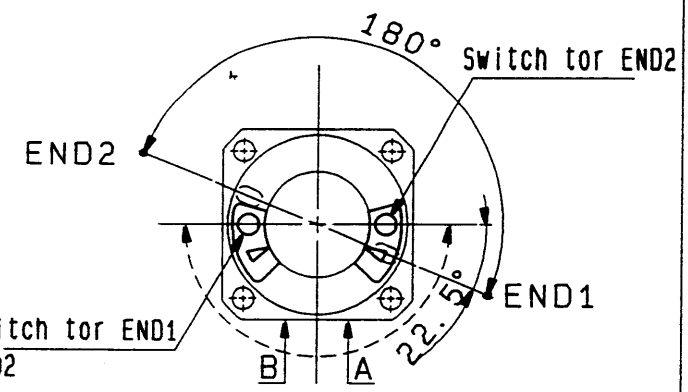
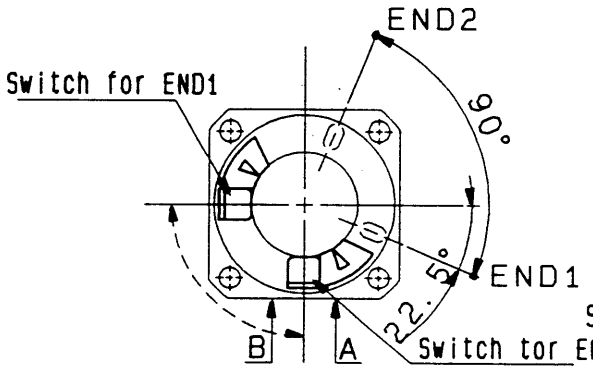


Figure 16

MSUB 7·20 90°



180°

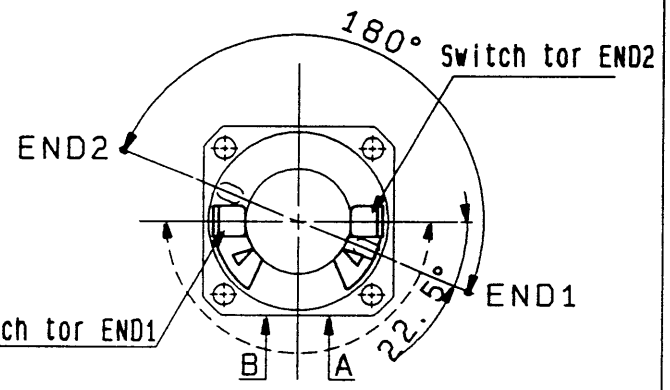


Figure 17

- In the figures 16 and 17, which indicate the rotating range, the angle 90° (180°) indicated by the arrow with solid line shows the range of the rotating pin hole for positioning, if the pin hole is at END1, the switch tor END1 will operate, and at END2, the for END2 will operate.
- The angle indicated by the arrow with dotted line shows the rotating range of the built-in magnet, the switch for END1 moves clockwise, the switch for END2 moves unticlockwise, and operating angle of each switch might be smaller.

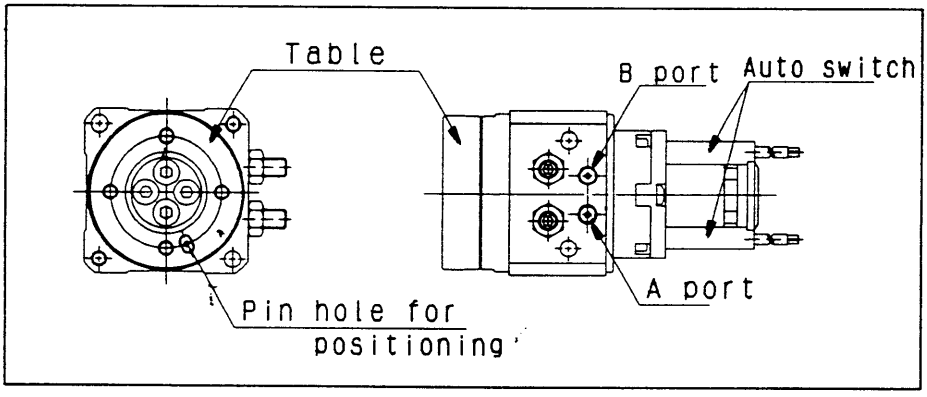


Figure 18

6-3 How to change Position for Detecting Auto Switch

As for setting the detecting position, loosen the holding set screw a little, move the switch, tighten and fix the screw after setting the position at the required position. In this time, if the screw is tighten too strong, the screw will be damaged and not be able to fix. Therefore, tightening torque should be around 0.5N·m.

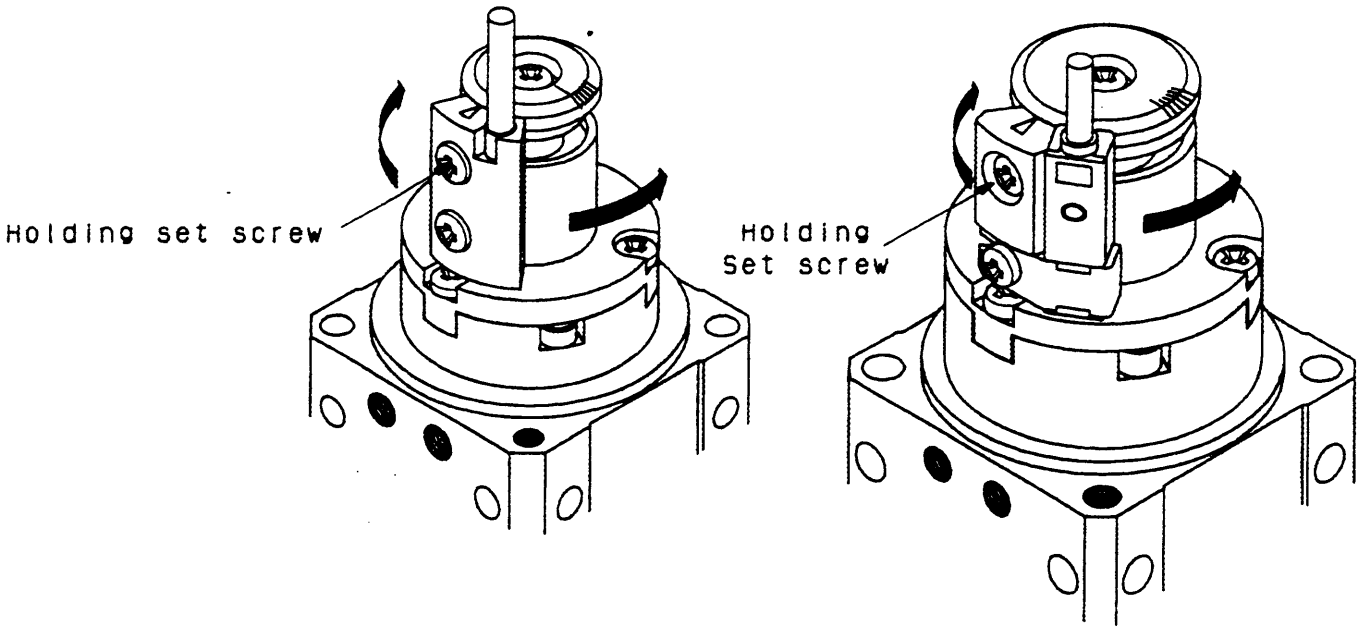


Figure 19

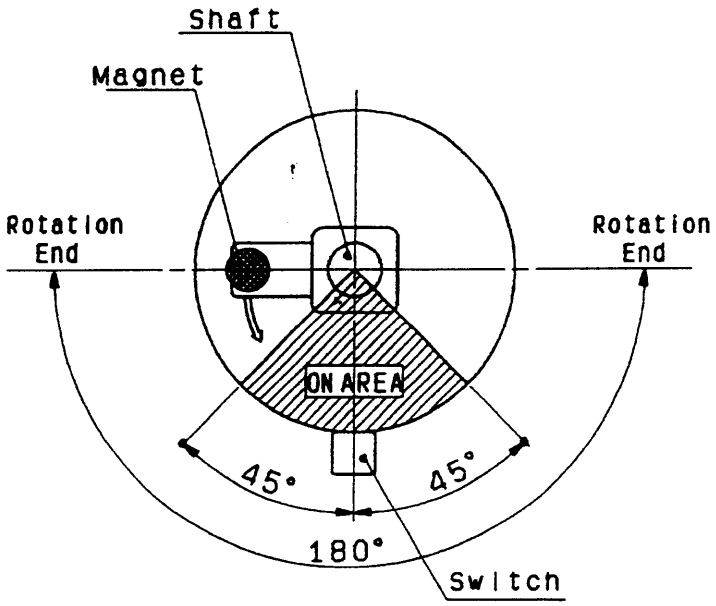
6-4 Operation Range and Differential of Auto Switch

Table 12

Size	Reed Switch		Solid State	
	Operation Range	Differential	Operation Range	Differential
1	110°	10°	110°	10°
3	110°	10°	110°	10°
7	90°	10°	90°	10°
20	90°	10°	90°	10°

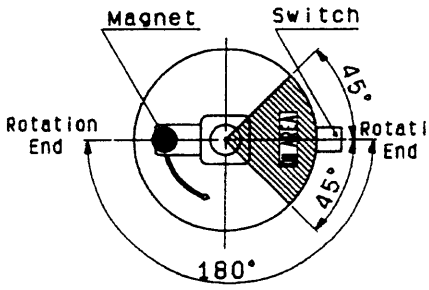
6-5 Operation Range and Differential Range

(Example)
Rotary Actuator --- 180°
Operation Range of Switch --- 90°
The switch is mounted in the middle of the rotation range.

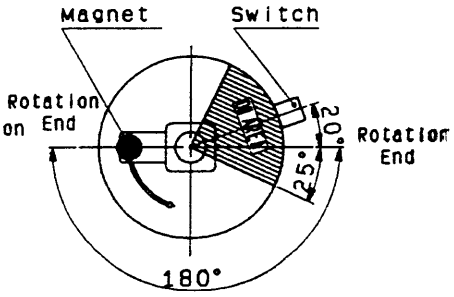


In the above mentioned figure, when the magnet rotates to the→ direction following the rotation of the shaft, the switch will turn ON if the magnet pass A point, and the switch will turn OFF if the magnet pass B point. In this case, ON area is 90° , that is, the rotation range of the switch is 90° .

(Example)
Rotary Actuator---180°
Operation Range of Switch---90°
The switch is mounted in the end of the rotation range.



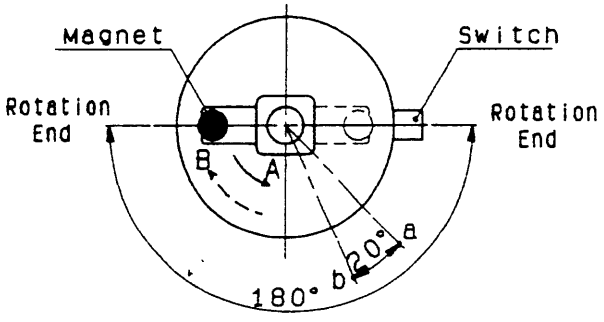
Figure(A)



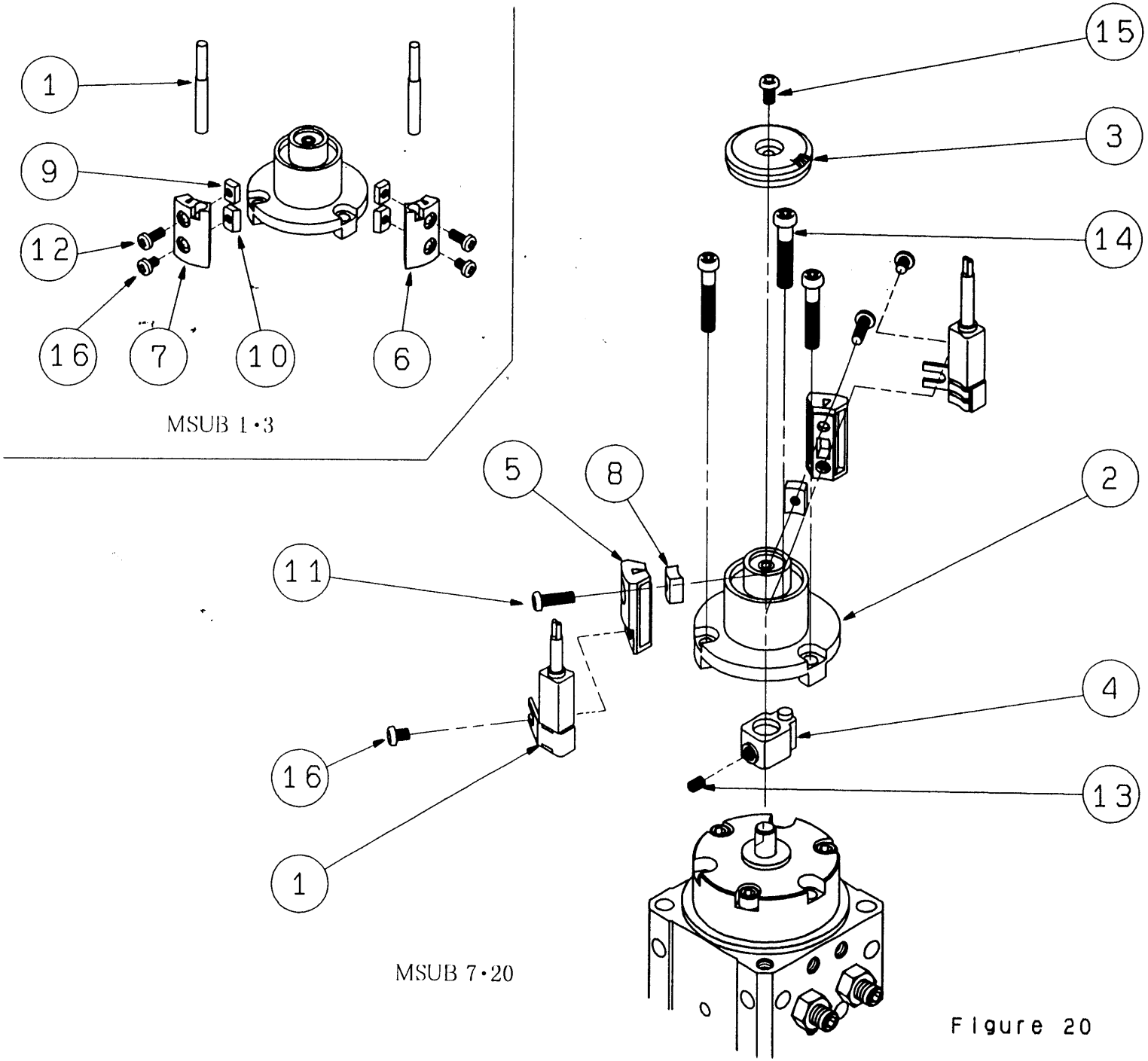
Figure(B)

In the figure(A), when the magnet rotates to the → direction, the switch turns ON at the 45° point before the rotation end where the switch is mounted. If the switch is slided 20° mentioned in the figure(B), the point where the switch turns ON could be changed to the 25° point before the rotation end.

(Example)
Rotary Actuator---180°
Differential of Switch---20°



In the above mentioned figure, when the magnet rotates to the A direction (solid line), the switch turns ON at the a point. Then when the magnet reversed to the B direction(dotted line), the switch turns OFF at the b point.
In this case, the Differential between the a point and the b point, 20° , is the switch Differential range, 20° .



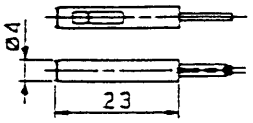
No.	Name.	Pes.
16	Cross Recess Round Head Screw	2
15	Cross Recess Round Head Screw	1
14	Cross Recess Round Head Screw	3
13	Hexagon Socket Head Set Screw	1
12	Cross Recess Round Head Screw	2
11	Hexagon Socket Head Screw	2
10	HOlding Block(B)	2
9	Holding Block(A)	2
8	Holding Block	2
7	Switch Block(B)	1
6	Switch Block(A)	1
5	Switch Block	2
4	Magnet Lever	1
3	Cover(B)	1
2	Cover(A)	1
1	Auto Switch	2

Rotary Table with Switch

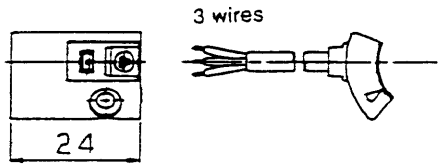
Figure 20

6-7 Schematic Drawing of Each Switch

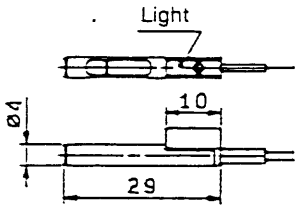
(D-90), (90A)



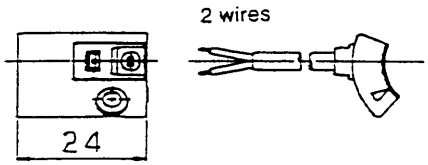
(D-S99V), (D-S9PV)



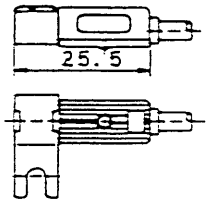
(D-97), (D-93A)



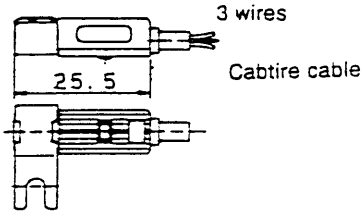
(D-T99V)



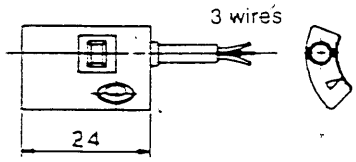
(D-R73), (D-R80)



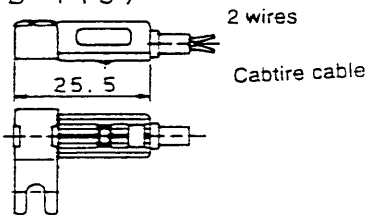
(D-S79), (D-S7P)



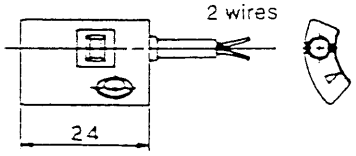
(D-S99), (D-S9P)



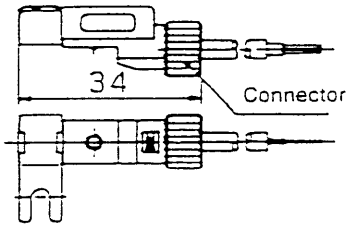
(D-T79)



(D-T99)



(D-R73CN), (D-R80CN), (D-T79CN)



7. Maintenance/Inspection

In order to operate actuators in the best condition, a periodical inspection is needed corresponding to operating conditions.

In general, the inspection actuators should be performed once a year.

7-1 Periodical Inspection

Followings are the points to be checked in the periodical inspection.

(1) Loosening of mounting screws for actuators.

(2) Loosening of mounting frames for actuators.

(3) Whether the products operate smoothly.

(4) Outside Leakage.

As a result of checking the above mentioned points, if defect is detected, tighten again or change actuators.

7-2 Countermeasures for Malfunction

Contents of Malfunction	Causes	Countermeasures	Reference Page
An actuator does not operate.	Pressure is not supplied correctly.	Set a regulator at the supply pressure side correctly	2 6
	A direction change valve(a solenoid valve etc.)does not switch.	Send a signal to a direction change valve(a solenoid valve etc.) correctly.	6
	Air leak from piping.	Inspect piping and stop leak.	6
Smooth operation is not available.	There is a sectional friction at a load.	Reduce frictional resistance.	
	Output is short because supply pressure is low.	In order to operate stably, adjust supply pressure to make the load rate within 50 %.	2
	A speed controller is throttled too much.	Since the range of speed control of an actuator in each size is different, re-adjust the speed controller.	2 6
Rotation angle changes exceedingly.	Inside parts are damaged.	Change to a new actuator. After that, deal with as follows. a) Calculate kinetic energy worked on an actuator, and adjust a speed controller. b) Mount a shock absorber outside to absorb impact force. c) Mount a stopper outside, not to affect an actuator by impact force. In this case, set an adjusting bolt not to touch an inside stopper lever, and determine the rotation end exactly with an external stopper.	11 12 13 14

Contents of Malfuction	Causes	Countermeasures	Reference Page
Leakage from a table section	Piston packing is worn.	Change to a new actuator.	
Rotation angle is not sufficient.	MSU series have an angle adjusting system. The angle is set smaller than the rotation angle which needs an adjusting bolt.	Set an adjusting bolt at the proper position. If the bolt is loosened exceedingly, the stopping surface of the stopper lever will be removed from the bolt. So adjust the bolt little by little.	7
The auto switch does not turn ON or OFF.	The auto switch is not mounted on the proper position	Mount the auto switch on the proper position.	16 17