Document No. : CRB1-0M00005-B

Operation Manual

Rotary Actuator

CRB1 Vane type

CRB1※W50, 63, 80, 100

- 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 ISO 4414※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) 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 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, food and beverage, 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.

1. General A

This operation manual describes the vane type rotary actuator. As the product is provided with such operating conditions as the magnitude of load (moment of inertia), oscillating time, and so on, please ensure the product operates with the specifications given.

1)Specifications

Table 1

Size	CRB1BW50	CRB1BW63	CRB1BW80	CRB1BW100	CRB1BW50	CRB1BW63	CRB1BW80	CRB1BW100
Type of vane	Single vane				Double vane			
Oscillating angle	90° $^{+4°}_{0}$, 180° $^{+4°}_{0}$, 270° $^{+4°}_{0}$ *(100° $^{+4°}_{0}$, 190° $^{+4°}_{0}$, 280° $^{+4°}_{0}$)				90° $^{+4°}_{0}$ *(100° $^{+4°}_{0}$)			
Operating fluid	Air (Non lube)							
Proof pressure	1.5 MPa							
Max. operating pressure	1.0 MPa							
Min. operating pressure	0.15MPa							
** Speed controllable range	0.1~1sec/90°							
Operating fiuid and abbient temperature	5~60°C							
Shaft type	Tow shaft(Key is applied to extended axis side and 4 chamfering is applied to the short axis side.)							

B

* The parenthesized value is the one for the semi-standard.

**As the low speed operation which is lower than 1s/90° causes sticking or operation stop, pay attention to the speed control.

Size			CRB1BW50	CRB1BW63	CRB1BW80	CRB1BW100		CRB1BW50	CRB1BW63	CRB1BW80	CRB1BW100
Type of vane			Single vane				Double vane				
Allowable kinetic energy			0.082J	0.12J	0.398J	0.6J		0.112J	0.16J	0.54J	0.811J
Internal volume cm^3		90°	30	70	88	186	90°	48	98	136	272
		100°	32	73	93	197					
		180°	49	94	138	281					
		190°	51	97	143	292	100°	52	104	146	294
		270°	66	118	188	376					
		280°	68	121	193	387					
Port size	Body size		Rc 1/8		Rc 1/4		Rc 1/8			Rc 1/4	
	Axial direction		Rc 1/8		Rc 1/4		Rc 1/8			Rc 1/4	
Mass g	Body	90°	810	1361	2070	3990	90°	830	1409	2120	4150
		100°	808	1358	2065	3980					
		180°	790	1327	2010	3880					
		190°	788	1324	2005	3870	100°	822	1399	2100	4100
		270°	770	1289	1950	3760					
		280°	766	1284	1940	3735					
	Foot Ass'y		384	784	993	1722		384	784	993	1722

A

Controllable speed range

Table 3

Model	Oscillating time (s/90°)
CRB1BW 50 CRB1BW 63 CRB1BW 80 CRB1BW100	0.1~ 1

Since an oscillation time exceeding the upper limit(1s/90°) may cause some sticking, ensure to operate the machine at a speed within the controllable speed range.
The max. speed 0.1/90° is the value obtained upon the condition that the machine is operated at an operating pressure of0.5MPa and under no load without the useof speed controller.

Air consumption

Air consumption for one cycle (reciprocation)

$$Q = (V \times 10^{-3}) \times \frac{P+0.1013}{0.1013} \times 2$$

Q: Air consumption per cycle ℓ(ANR)
V: Internal volume (cc)
P: Operating air pressure (MPa)

*: The volume in piping section is excluded.

2) Effective torque output

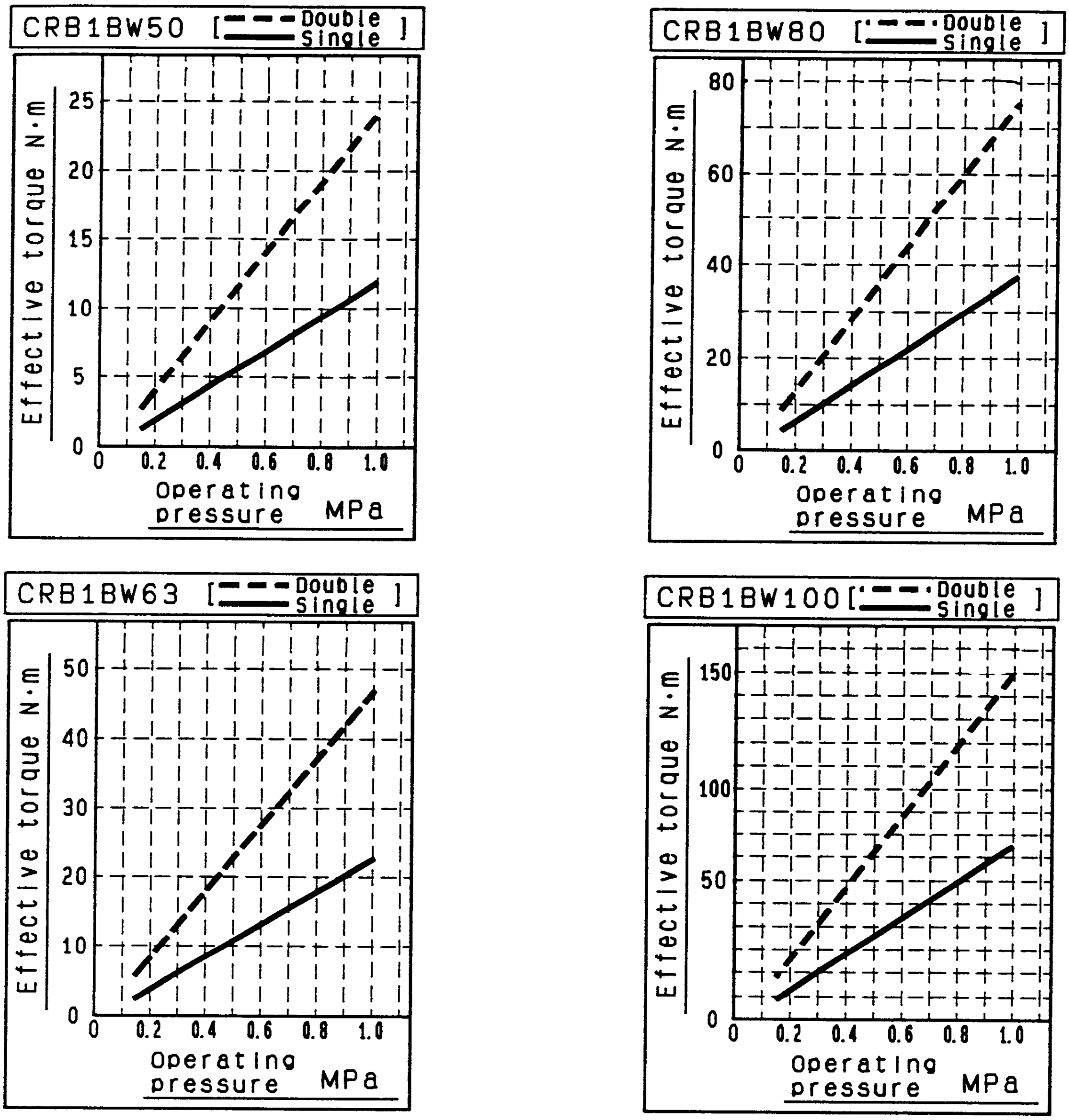
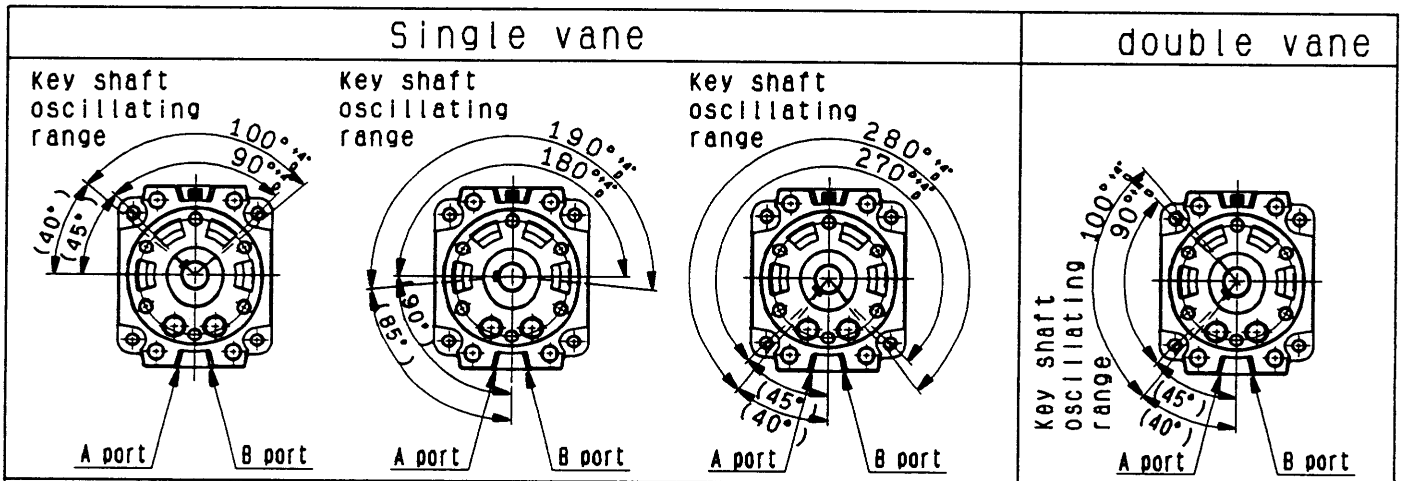


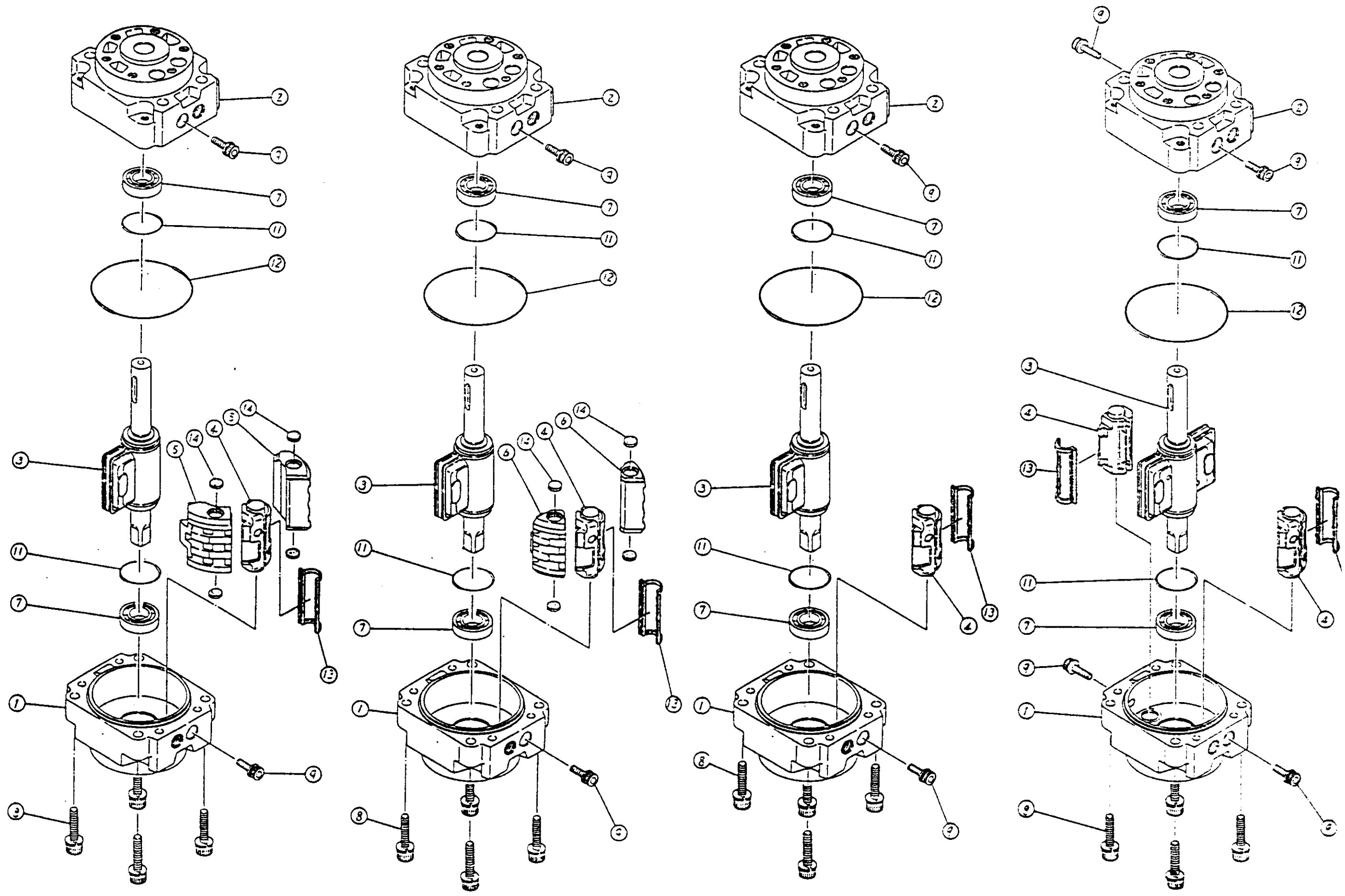
Figure 1 Effective torque output

3) Key (key groove) position and sahft oscillating ramge (Key axis view)

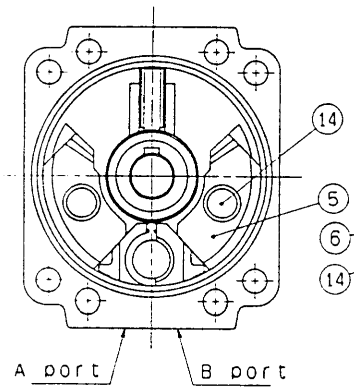


The key position shown above indicates the condtion that pressure isis applied from the B port.
When pressure is applied from Aport under the adove condition.the key (key groove)rotates clookwise.

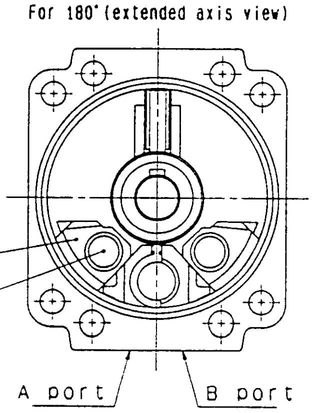
2. Internal Structure and Part Name



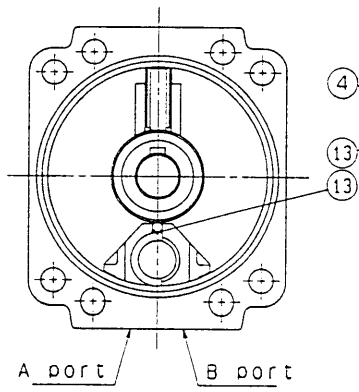
For 90° (extended axis view)



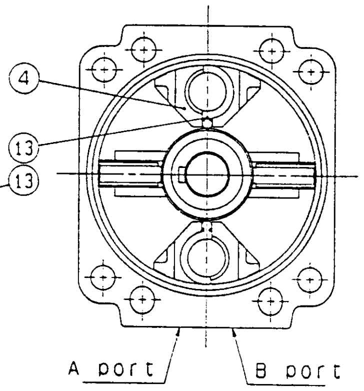
For 180° (extended axis view)

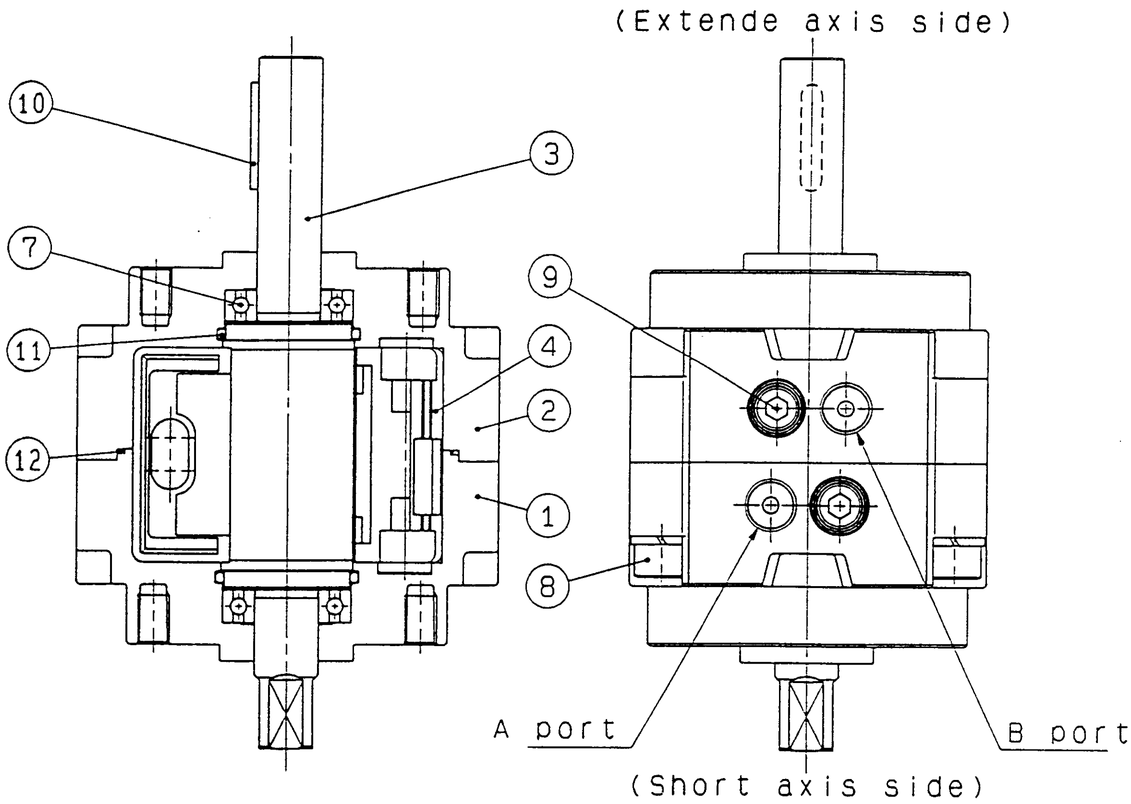


For 270° (extended axis view)



Double vane type:
For 90° (extended axis view)





Parts list

No.	Part name	Meterial	Note
1	Body (A) *)	Aluminum alloy	Coating
2	Body (B) *)	Aluminum alloy	Coating
3	Vane shaft	Carbon steel	
4	Stopper	Aluminum alloy	
5	Stopper	Resin	For 90°
6	Stopper	Resin	For 180°
7	Bearing	High carbon chrome shaft bearing steel	
8	Hexagon socket head bolt (With washer)	Carbon steel	
9	Fuji lock bolt	Carbone steel	
10	Parallel key	Carbone steel	

*)Aluminum is used as for CRB1BW100.

Packing list

No.	Part name	Material	Note
11	"O" ring	NBR	ARP568
12	"O" ring	NBR	Special O ring
13	Stopper packing	NBR	Special packing
14	Holding rubber	NBR	

3. Basic Circuit used in Rotary Actuator

1) Basic circuit diagram

The basic circuit using air filter, regulator, solenoid valve and speed controlled valve and speed controller to operate the rotary actuator is as shown in Figure 3 below.

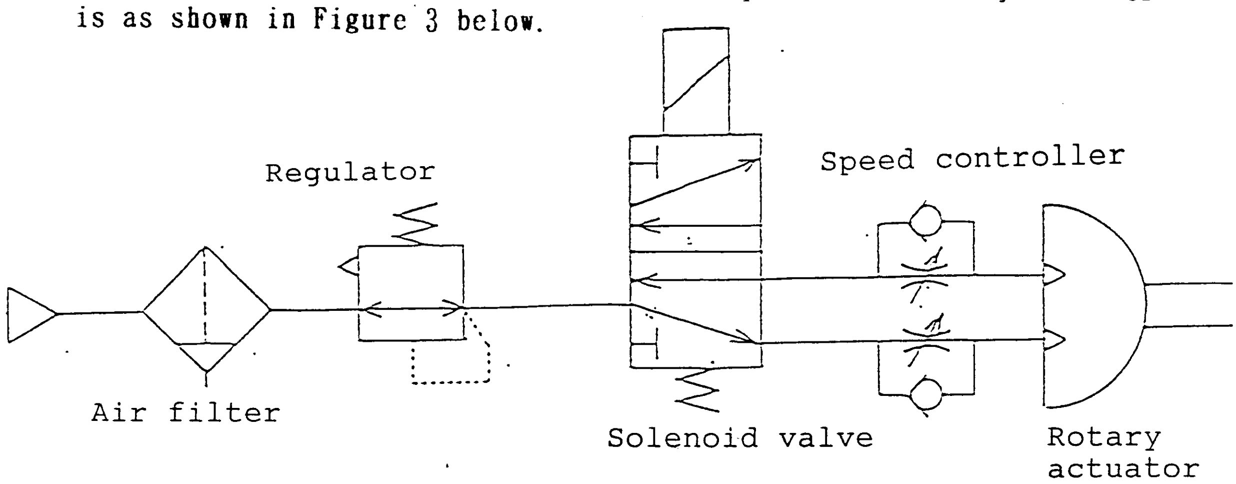


Fig. 3 Basic circuit

2) Recommended circuit components

The solenoid valve, speed controller, and tube used in the basic circuit shown in Figure 3 are listed in Table 5.

Model	Solenoid valve Cv Factor	Speed controller	Tube
CRB1BW 50	Cv=0.2～0.5	Piping type AS2000－1/8 AS3000 AS4000 Straight pipe type AS2200 Piping type with one touch fitting AS2051F AS3001F Straight pipe with one touch fitting AS2201F－1/8, 1/4 AS2301F－1/8, 1/4	ϕ 6／ϕ 4
CRB1BW 63	Cv=0.3～0.5		
CRB1BW 80	Cv=0.5～1.0		ϕ 8／ϕ 6
CRB1BW100			ϕ 10／ϕ 6.5

4. Mounting of the Actuator A

1) Shaft load limitations

In the static load condition, values up to those shown in Table 5 below may be applied to the such a loading shaft. However, if possible, avoid applying directly to the shaft.

B

Table 5 Allowable Shaft Loading

Unit: N

Model	Fr	Fs
CRB1BW 50	245	196
CRB1BW 63	390	340
CRB1BW 80	490	490
CRB1BW100	588	539

*The point to which Fr is applied is the center of the longitudial length of the key groove.

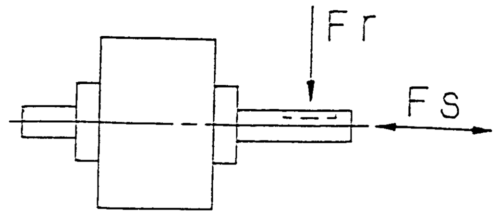


Figure 4 Load direction

For ideal operating conditions, We recommend the user to take the following steps to ensure loading is not directly applied to the shaft.

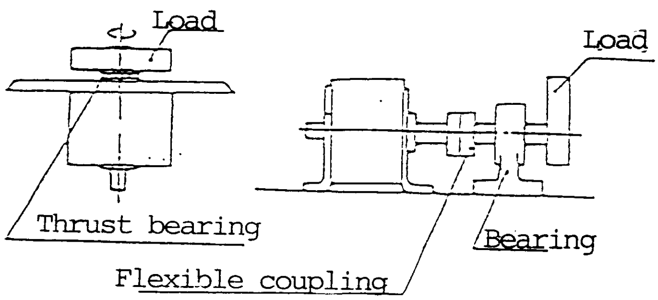


Figure 5

2) Use of shaft joint

As in Figure ,6 if the shaft of the rotary actuator is extended, the shaft of the rotary actuator must be centered. If this is not carried out then during operation, the load factor of the shaft may become too high and excess bending moment applied to the shaft. Therefore, stable operation of the rotary actuator can not be expected and damage to the shaft may be caused. To protect against this, the use of a flexible joint (e.g; flexible coupling defined in JIS standard) to connect the shaft and counter shaft is necessary.

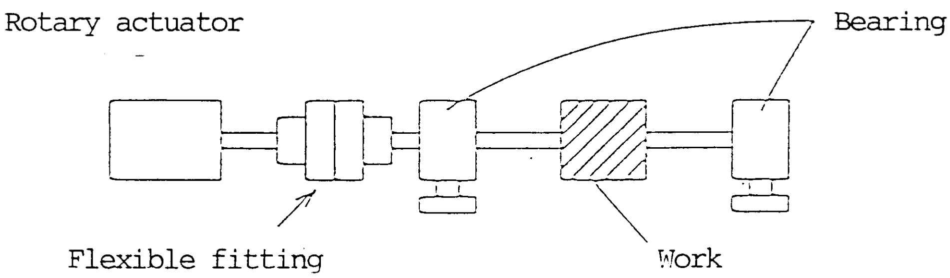


Figure 6

3) For the case when the main unit of the actuator is used as flange
The following table shows the L length of the main unit.
We recommend the use of the hexagon socket head cap screw enabling the head of the JIS standard bolt to be fitted well in the recess of the actuator.

Table 6

Model	L	Bolt used
CRB1BW 50	48	M 6
CRB1BW 63	52	M 8
CRB1BW 80	60	M 8
CRB1BW100	80	M10

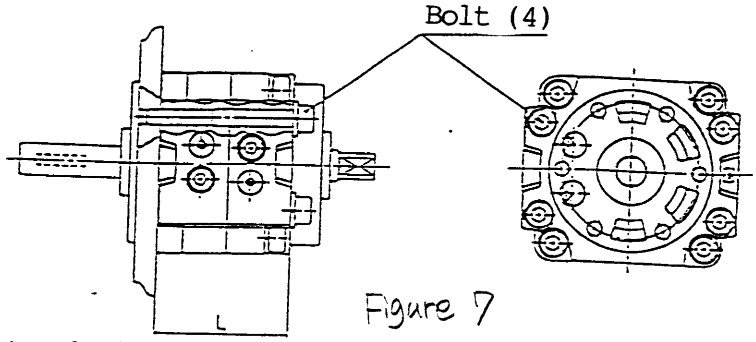


Figure 7

4) Piping

a) Dust adherent to the inside of piping before the filter can be removed by the filter, while on the contrary the dust adherent to the inside of piping after the filter can not be removed. Therefore, unless precautions are taken, it enters directly into the inside of the solenoid valve and cylinder and causes malfunction or shortens their life expectancy. Therefore, please be sure to flush the inside of piping before connecting any equipment.

b) When connecting piping, Joints and so on, be careful to ensure chips or piping threads and sealant does not enter piping. In addition, when using sealing tape, wind the thread part with seal tape leaving 1.5 to 2 threads unwound.

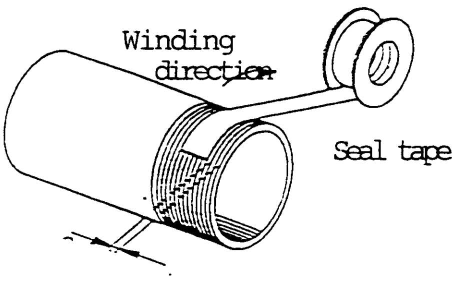


Figure 8 How to wind seal tape

5) Air supply
When supplying the rotary actuator with air, use filtered clean air. Since the CRB1 Series can be operated without oil supply, it is unnecessary to use any lubricator for oil supply. If lubricator is used for oil supply, lubrication must be continued. (For oil supply, use 1st grade turbine oil (ISOVG32) or equivalent.)

5. Setting of Oscillating Time

Even when the torque generated by the rotary actuator is small, it may sometimes occur that the inertia force of the load causes damage to the shaft of the actuator and its internal components. When operating the rotary actuator, it is necessary to preset the oscillation time for the actuator by calculating the moment of inertia of the load and its kinetic energy.

1) Moment of inertia

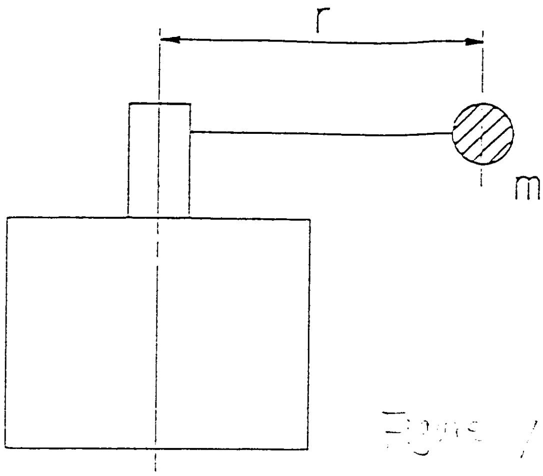
Moment of inertia means the degree of difficulty in turning a material object, or conversely it represents the degree of difficulty in stopping the rotating object. However, although the rotary actuator stops at the stroke end, since the object has a moment of inertia, it applies a great impact (kinetic energy) to the rotary actuator.
The kinetic energy applied is calculated by the following equation.

$E = 1/2 \cdot I \cdot \omega^2$

E: Kinetic energy J
I: Moment of inertia $kg \cdot m^2$
ω: Angular velocity rad/s

As the kinetic energy allowed by the rotary actuator is limited in magnitude, the limited value for the oscillating time can be obtained by calculating the moment of inertia. The following describes how to calculate moment of inertia. The basic equation of the moment of inertia is as follows.

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



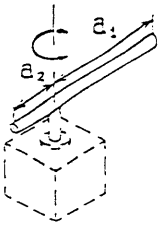
The above represents the moment of inertia of Mass M at a point distant by r from the axis of rotation relative to the axis of rotation. The equation of the moment of inertia is different with the shape of the weight body. The following table shows various equations for obtaining the moment of inertia of bodies having different shape.

How to calculate a moment of inertia

I: Moment of inertia, $kg \cdot m^2$, m: Load mass kg

① Small-diameter bar

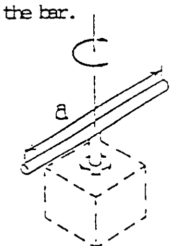
The case where the center line of ratation axis passes through a point perpendicular to the bar.



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

② Small-diameter bar

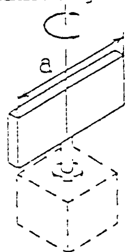
The case where the center line or rotation axis passes through the center of gravity perpendicular to the bar.



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

③ Thin rectangular plate (rectangular parallelopiped)

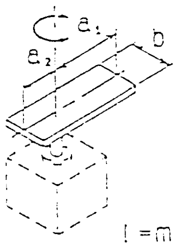
The case where the center line of rotation axis passes through the center of gravity of the plate in parallel to side b.



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

④ Thin rectangular plate (rectangular parallelopiped)

The case where the center line of rotation axis passes through a point in one end of the plate and perpendicular to the plate.

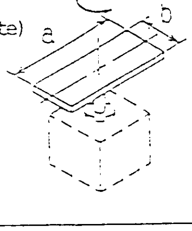


$$I = m_1 \cdot \frac{4a_1^2 + b^2}{12} + m_2 \cdot \frac{4a_2^2 + b^2}{12}$$

⑤ Thin rectangular plate (rectangular parallelopiped)

The case where the center line of rotation axis passes through the center of gravity of the plate and perpendicular to the plate.

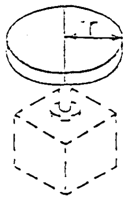
(The same as the case of a thick rectangular plate)



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

⑥ Cylinder (including thin disc)

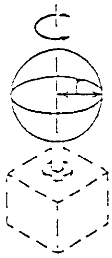
The case where the center line of rotation axis passes through the center of gravity of cylinder and perpendicular to the cylinder.



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

⑦ Solid sphere

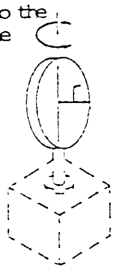
The case where the center line of rotationaxis passes through the center of the sphere.



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

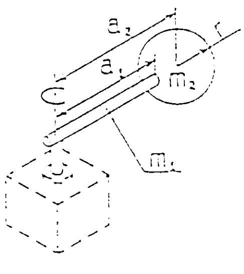
⑧ Thin disc

The case where the center line of rotation axis passes through the center of gravity of the disc in parallel to the flat surface of the disc.



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

⑨ If load is the end of lever.



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

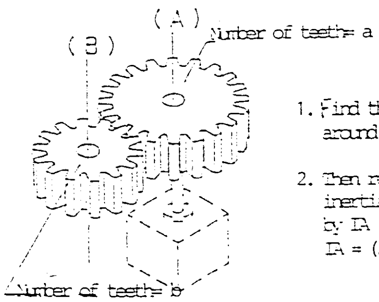
(EX) when the shape of m2 is a sphere, it will be

$$K = m_2 \cdot \frac{2r^2}{5}$$

according to ⑦.

* When it is supposed that $m_1 = 0$ and m2 is the all mass point, $I = m_2 \cdot a_2^2$

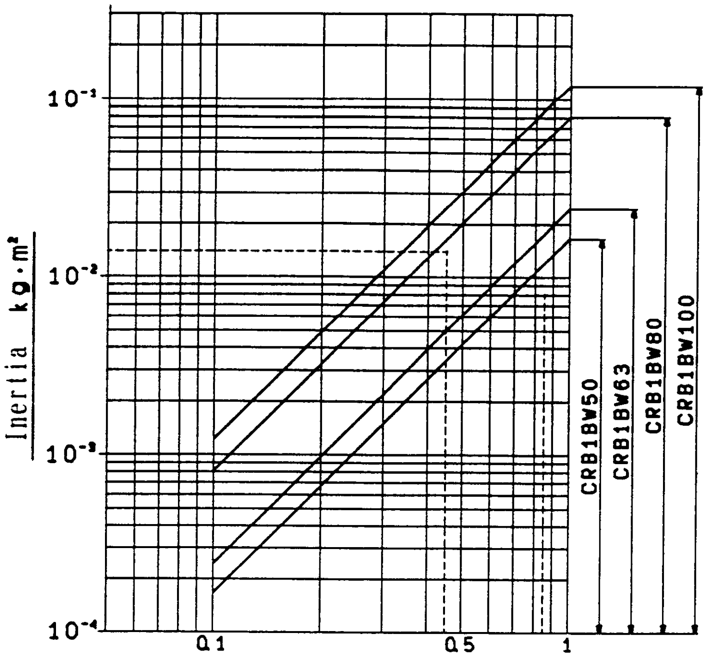
⑩ Propagation of gear



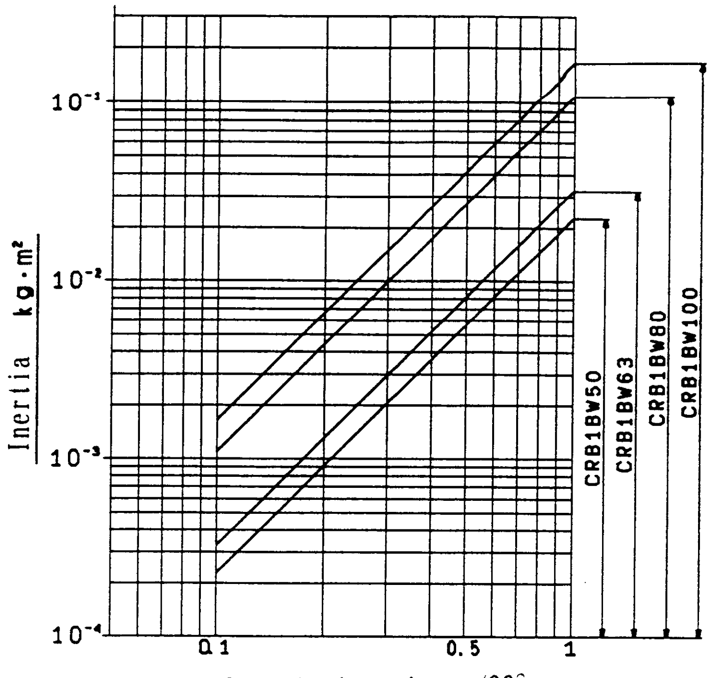
1. Find the moment of inertia IB around the shaft (B).
2. Then replace the moment of inertia IB around the shaft (A) by IA
   $IA = (a/b)^2 \cdot IB$

Moment of inertia and Oscillating Time

CRB1BW50·63·80·100 / Single vane



CRB1BW50·63·80·100 / Double vane



How to read diagram

Example 1: In the case of operating CRB1BW50 (single vane type) when the moment inertia is 0.0008kg·m² and the oscillation time is 0.85sec/90°.

Because the point of the intersection of the vertical line corresponding to 0.0008kg·m² and the horizontal line corresponding to 0.85sec is under the energy curve, the operation is available.

Example 2: In the case of operating CRB1BW50 (single vane type) when the moment inertia is 0.0014kg·m² and the oscillation time is 0.45sec/90°.

Because the point of the intersection of the vertical line corresponding to 0.0014kg·m² and the horizontal line corresponding to 0.45sec is over the evergy curve, the operation is not available.
In this case, change the model of the upper machine or use the external stopper (shock absorbing mechanism) in order to stop the loading itself.

A

2) Kinetic energy

Table 7 shows allowable kinetic energy for each model of the rotary actuator.

Table 7

Size	Type of vane	Allowable kinetic energy (J)	Adjusttable range of oscillating time (s/90°)
50	Single vane	0.082	0.1~1.0
	Double vane	0.112	
63	Single vane	0.12	
	Double vane	0.16	
80	Single vane	0.398	
	Double vane	0.54	
100	Single vane	0.6	
	Double vane	0.811	

The actuator may sometimes reach to the oscillating end during acceleration. In such a case, the terminal angular velocity ω of the actuator is obtained as follows.

$\omega = 2\theta/t$ θ: Oscillating angle (rad)
t: Oscillating time (s)

As the kinetic energy E is represented with the following equation, the oscillating time t of the rotary actuator is expressed as follows.

$$E = 1/2 \cdot J \cdot W^2$$

$$t \geqq \sqrt{2 \cdot J \cdot \theta^2 / E}$$

Where, E: Allowable kinetic energy (J)
J: Moment of inertia ($kg \cdot m^2$)
θ: Oscillating angle (rad) 180° =3.14 rad

When t seconds pass in uniform angular acceleration motion, angular velocity ω and seconds of arc θ are obtained as follows.

$\omega = \dot{\omega} \times t$ ----- (1)

$\theta = \int \dot{\omega} t dt = 1/2 \dot{\omega} t^2 \div C$ ---- (2)

where C is an integral constant.

As seconds of arc θ at t = 0 becomes zero, integral constant C also becomes zero. Therefore, θ is obrained as follows.

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

Therefore, ω is obtained as follows.

$\omega = 2\theta/t$

3)External stopper

When the kinetic energy generated by load exceeds the allowable kinetic energy of the actuator, a shock absorbing mechanism must be externally prepared to absorb the inertia force.

The following explains a correct method of mounting the external stopper schematically.

※ As the actuator itself contains a slight amount of angular difference due to its structure, when it is necessary to make positional accuracy, use the external stopper, too.

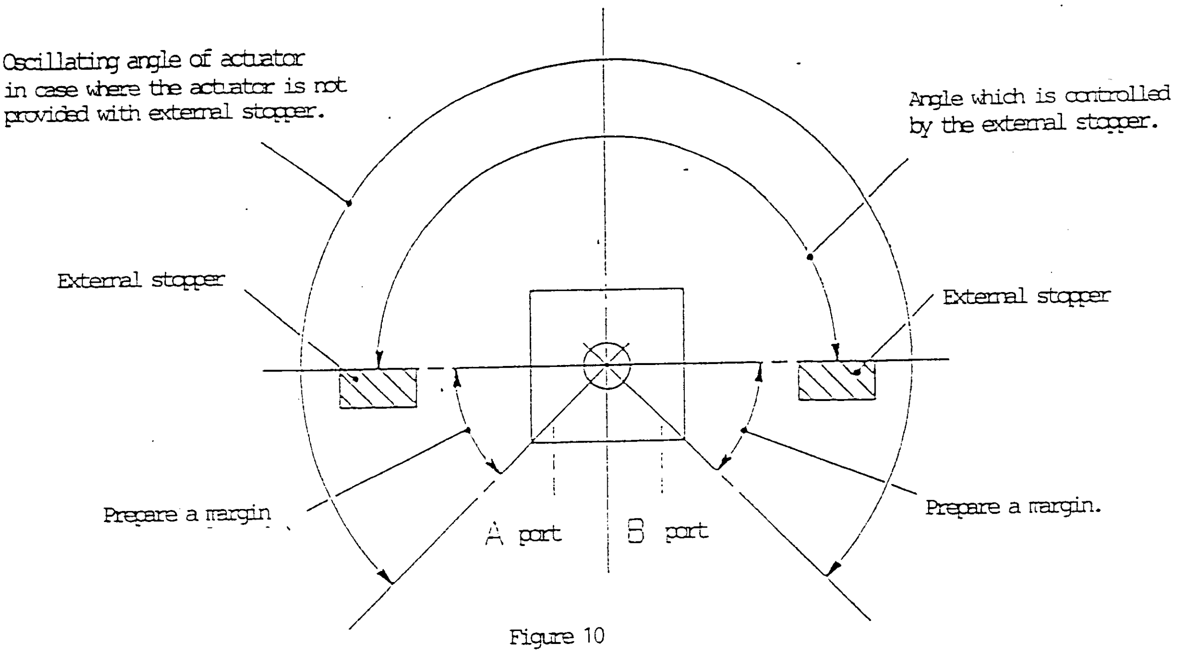
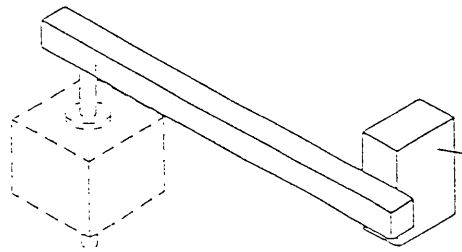


Figure 10

Valid



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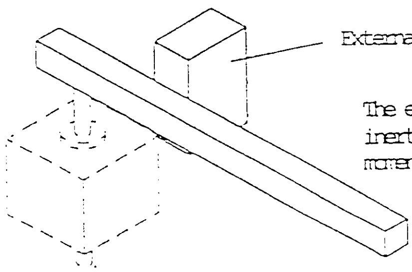
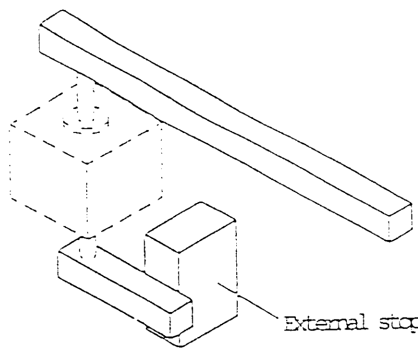


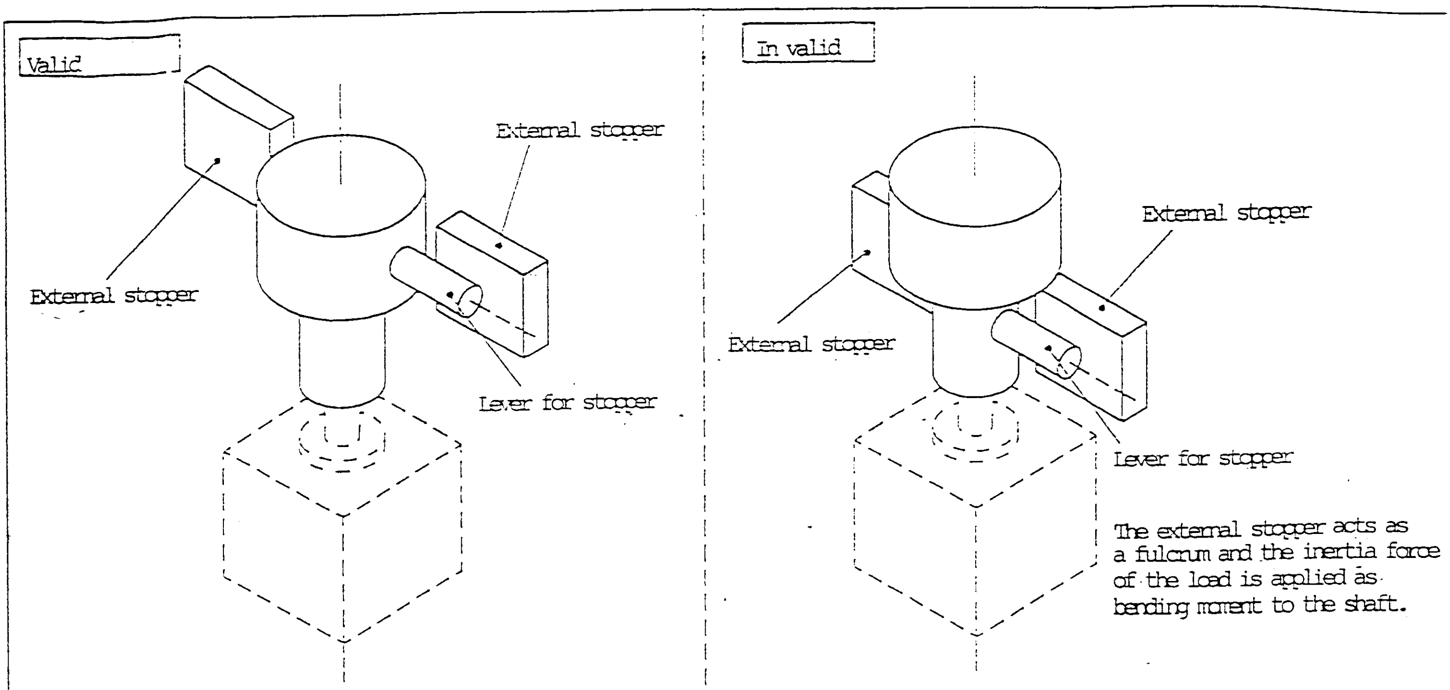
The external stopper work as a fulcrum and the inertia force of load is applied as bending moment to the shaft.

Invalid



If the actuator is equipped with such shock absorbing function as shock absorber and the load applied is within an allowable kinetic energy, the use of one side shaft is allowed.

When external stopper is attached to the shaft on the side opposite to the load applied, the moment of inertia generated by the load is directly applied to that shaft.



In case no external stopper is available for the actuator, if the kinetic energy of load is reduced by changing the oscillating velocity, load weight, load shape, and so on, the external stopper can sometimes be used.
Figure 11 below shows an example of reducing the kinetic energy.

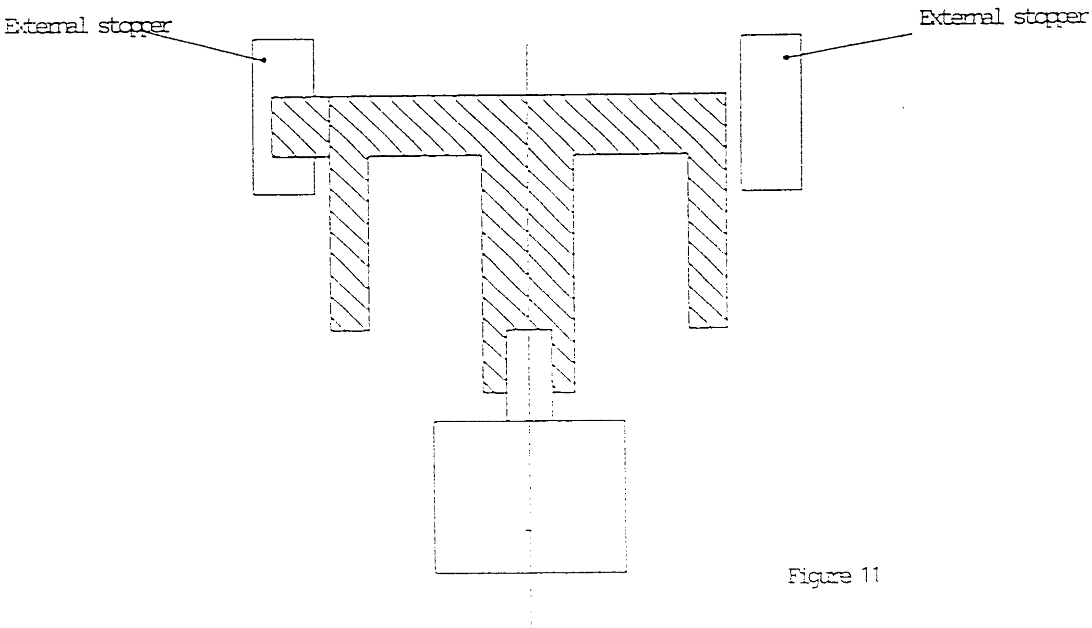
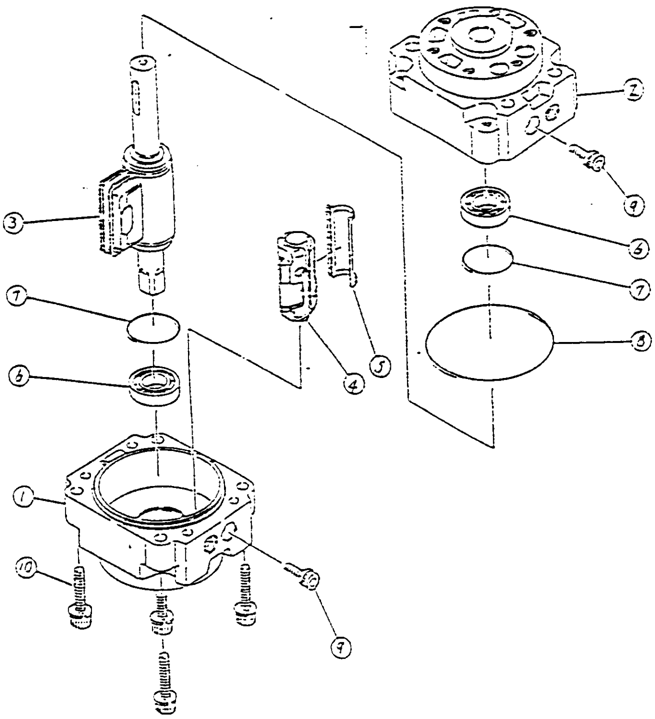


Figure 11

6. Maintenance and Inspection



- Ensure to install an air filter in order to keep the supply air clean.
- Apart from a breakdown, do not disassemble the actuator.
  If this is unavoidably necessary, disassemble the actuator in the following sequence, keeping it well away from dirt and other foreign matters.
  Almost all operating faults are due to an increase in internal leakage.
  Accordingly, it is necessary to readjust the speed controller. It is recommended that the actuator is used in the range of stable speed control (See Page 1 "Speed control")

Disassembly
(1) Remove Fuji-lock bolts ⑨.
(2) Remove hexagonal soccket cap bolts ⑩.
(3) Fix either body (A)① or body (B)②, then push out vane shaft③ and separate body (A) from body (B).
(4) Extract vane shaft③ and stopper④.

Reassembly
(1) Mount vane shaft③ to body (B)②.
(2) Mount stopper packing⑤ to stopper④.
(3) Mount stopper④ to body(B)②.
(4) Insert body(A)① into vane shaft③.
(5) Fix body(A)① and body(B)② using hex. socket cap bolts⑩
(6) Fix stopper④ using Fugi-lock bolts⑨.

Precautions

(1) Before disassembling the actuator, be thoroughly familiar with internal construction.

(2) During reassembly, take great care not to damage the corners of stopper packing⑤. (During disassembly and reassembly)

(3) Take great care not to damage sliding faces of body(A)①, body(B)② and vane shaft③.

(4) The rubber on vane shaft③ has been bonded and therfore cannot be disassembled.

7. Troubleshooting

Symptom	Likely cause	Remedy
Actuator does not operate. Check whether wrong adjustment of the oscillating speed causes this symptom by adjusting the speed controller	The oscillating speed is not within the controllable range.	Operate within the controllable range mentioned on the catalog.
	An increase in internal reakage due to the internal packing damaged by dirt and other foreign matters.	Replace the vane shaft, stopper packing and so forth. (Generally, replace of the machine itself is required.)
	Defect of the internal packing or an increase in internal resistance (including congelation).	a. Operate within the operating temperature. (in the case of the defect of packing, replace vane shaft, stopper packing and so forth.)
	Defect of the supplementary equipments. a. Wrong adjustment of the speed controller b. Defective operation of the solenoid valve. c. Insufficient air supply due to the clogging of the air filter d. A reduction in the pressure due to defect of regulator.	Apply the protective equipment for each equipment. (Including the protection of the circuit.)
Breakage of shaft	Excessive load energy. a. Mass of load is too large. b. Operation speed is too fast. c. Radius of gyration is too large.	Replace the shaft a. Operate withing the allowable range of energy. b. Absorb the shock energy. Perform proper mounting of the cushion device, the external stopper.
	External force is applied besides the load energy.	Replace the shaft a. Avoid excessive external force
	Offset load due to the disalignment.	Replace the shaft.: Eliminate disalignment.