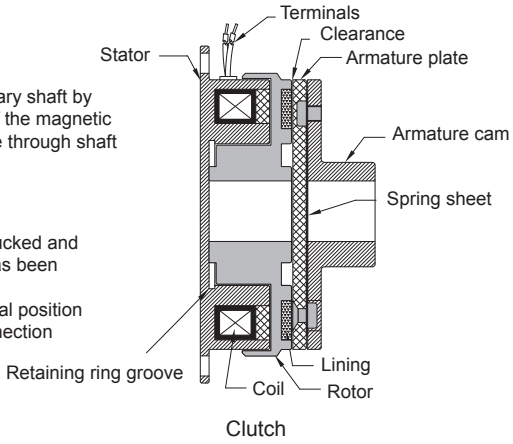
Electromagnetic clutch & brake

Basic structure of Clutches

The basic structure of Clutches contains stator of Built-in coil, rotor which filled with Lining and armature plate & spring sheet fixed on the armature cam.

The stator is mounted and fixed on a static components directly, such as bracket; the rotor is fixed on rotary shaft by a key; the stator and the rotor are combined to form a magnetic armature by a narrow air signal as a part of the magnetic circuit; the armature plate is opposed to the rotor and maintain a certain clearance; the armature unit for the through shaft is mounted on the shaft through a bearing.



Clutch

Working principle of Clutches

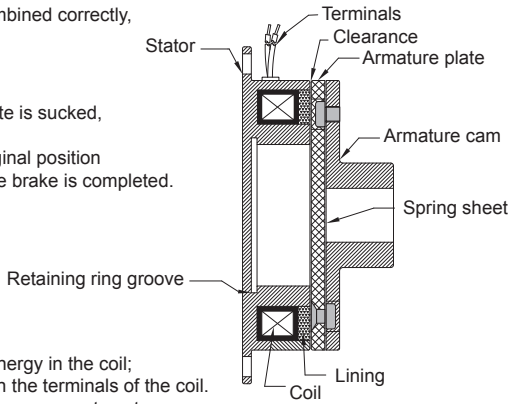
When the magnetic field coil is energized, the stator generates a magnetic field, the armature plate is sucked and connected, meantime, the spring sheet stretching, other parts remain motionless, the connection action has been generated.

When the power is off, the magnetic field disappears, and the armature plate is pulled back to the original position by the spring sheet due to the absence of the magnetic field, meantime, the clearance is formed, and connection disconnected.

Basic structure of Brakes

The basic structure of Brakes contains stator which filled with Lining and armature plate & spring sheet fixed on the armature cam.

The stator is fixed on on a static components of the machine by a mounting flange, such as bracket; the armature plate & spring sheet are opposed to the rotor and maintain a certain clearance, and be combined correctly, and then fixed on the brake wheel.



Brake

Working principle of Brakes

When the magnetic field coil is energized, the stator generates a magnetic field, and the armature plate is sucked, friction between the lining (on stator) and armature plate, the braking action has been generated.

When the power is off, the magnetic field disappears, and the armature plate is pulled back to the original position by the spring sheet due to the absence of the magnetic field, meantime, the clearance is formed, and the brake is completed.

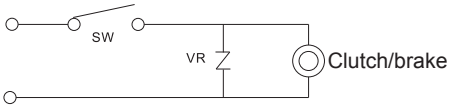
Features

1. Use constant load spring sheet to convey torque, no backlash, high-speed response;
2. Use low wear, high-end, non-asbestos lining, which has long life and good durability.

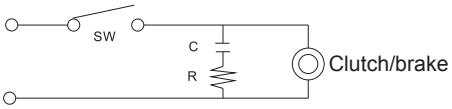
Basic circuit control

When the DC of field excitation flows through the coil of electromagnetic clutch/brake, accumulated energy in the coil; and when the current is cut off, the energy accumulated in the coil will generate Inverse Voltage between the terminals of the coil. The voltage can reach more than 1000V depending on the cut-off speed and the cut-off current. So, it is necessary to set up an appropriate protective circuits to prevent these problems due to it may become insulation break of the coil or bad contacts of switches.

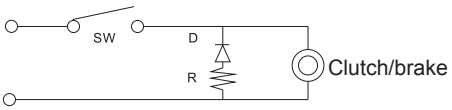
▶ Surge Absorber:
Great effect of suppressing surge, no delay of armature release time



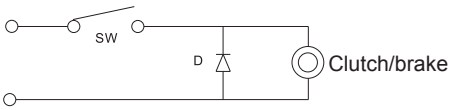
▶ Resistor + Capacitor: Armature release time speed, it's Necessary for Capacitors with high voltage resistance



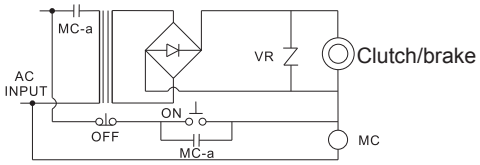
▶ Resistor + Diode: It can make the power supply consume less power, the resistance capacity can also be small, the armature release time is delayed, need to pay attention when it is high-frequency used.



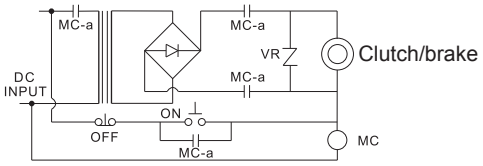
▶ Diode: The effect of suppressing shock wave is great, but the release time of armature will be prolonged, which will cause clutch/brake interference, so it is not suitable for high-frequency used.



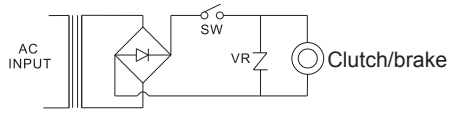
▶ The contact of electromagnetic relay is on the AC side, the contact capacity can be selected as small capacity, but the release time is longer than that when on the DC side.



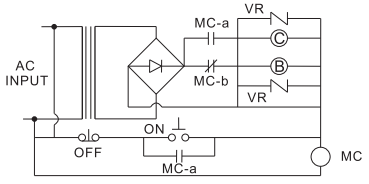
▶ The contacts of electromagnetic relay are on the DC side, so the vacancy of contacts should be about 8 times of the standard load.



▶ In order to control the basic circuit of clutch/brake, it is composed of Transformer, Rectifier, Surge Absorber and switch.



▶ This circuit is often used in clutch & brake unit. It is switched by electromagnetic relay a/b contacts.
If both of the clutch and brake are kept off, must add a switch to control it.



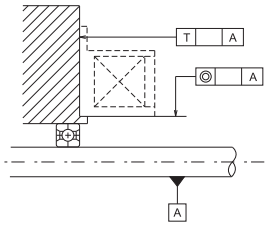
Installation & Design

Stator and Rotor Installation

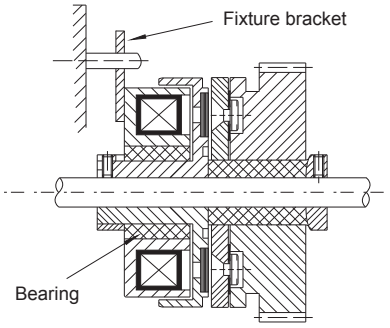
◆ Flange Type Stator Installation
For of this type of stator, please position the rotating shaft correctly first. For positioning, the inner and outer circles of the stator are fitted with tolerance grades.

Unit: (mm)

Specifications (kg/m)	0.6	1.5	2.5	5.0	10.0	20.0	40.0
Coaxiality (T.I.R)	0.08	0.08	0.1	0.1	0.12	0.12	0.14
Verticality (T.I.R)	0.05	0.05	0.05	0.07	0.08	0.13	0.13



◆ Bearing Type Stator Installation
The stator has built-in rolling bearings or sliding bearings, it only bears slight tangential force. So please fix it on the bracket of the static components of the machine to prevent the stator from dislocation rotating.



Magnetic shield of stator

When assemble the clutch/brake, the action of the clutch/brake may be unstable due to the magnetic influence between them. And if there are measuring instruments or instruments around the clutch/brake, there may be adverse effects to the clutch/brake, such as noise or misoperation.
In this case, please install a magnetic shield. Usually, we use non-magnetic material for the mounting surface and shaft of the stator.

Wire Protection

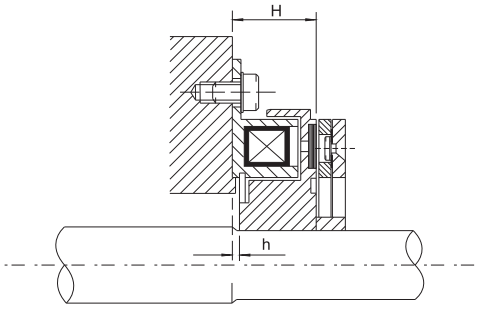
Once the outer skin of the wire is damaged, it's easy to cause short-circuit or break-down.
Please check and confirm its protection from the beginning of design.

Rotor Installation

Rotor is a part of magnetic circuit, the machining (expect aperture machining) may result in reduced performance, so please do not machine.
Expect the standard apertures listed in the dimension table, the others please contact us for advice.

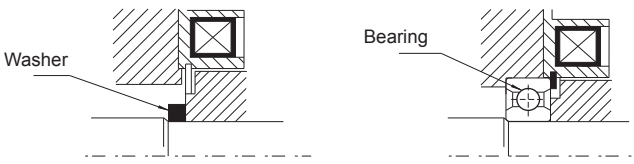
Relation between rotor and stator

The position relation between stator and rotor is very important for flange-mounted clutch.
The stator and rotor will contact each other if the size of "H" showed below is too small; and it will reduce the attraction if it is too large.
The following table is the allowable values for each size. Do not exceed these values in design. The allowable value of H should be designed according to the general allowable value of JIS standard.



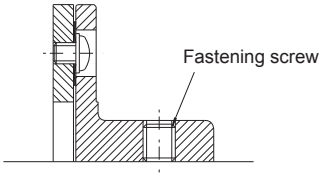
Unit: (mm)

Specifications (kg/m)		0.6	1.5	2.5	5.0	10.0	20.0	40.0
H	Benchmark value	24.0	26.5	30.0	33.5	37.5	44.0	51.0
	Admissible error	±0.2	±0.2	±0.3	±0.3	±0.3	±0.4	±0.4
h	Benchmark value	2.0	2.5	3.0	3.5	3.5	4.0	4.0

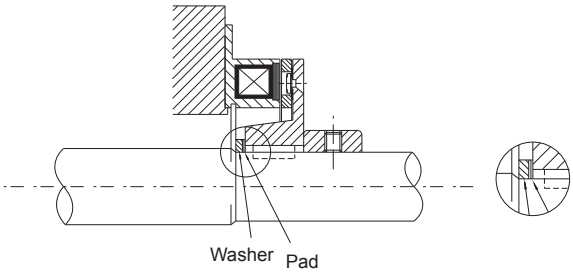


Armature Installation

◆ H-type Armature Installation
Please fix it with the attached inner hexagonal fastening screw.
Because of vibration or high-frequency operation, may cause screw loosening.
It is very effective to apply anti-loosening binder on the screw part.



◆ N-type Armature Installation
The sleeve part is concealed in the inner part of the stator.
As showed in below figure, please use C-shaped positioning ring or washer for fixing.



Installation & Design

Armature Installation

On the installation area, please machining the screw hole and the clearance of the screw or rivet head. When installing, please use attached special inner hexagonal bolts and butterfly spring pads, and apply a little anti-loosening binder on the screw part. (Please pay attention: if the binder is too much, it may penetrate into the spring sheet, which may cause movement obstacles!)

Installation screw don't need to chamfer, just removed the burr is OK.

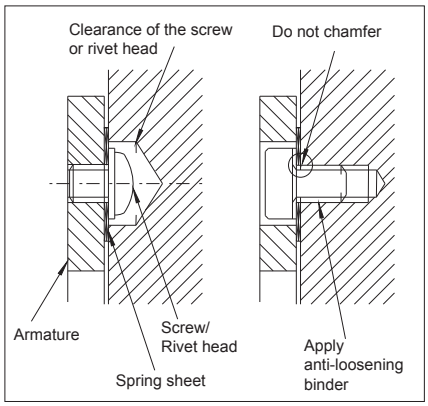
In accessories, the inner hexagonal bolt is a special type with lower stigma.

For butterfly spring sheet, please use as below pictures. If the used direction is opposite, the effect of tightening will become worse.

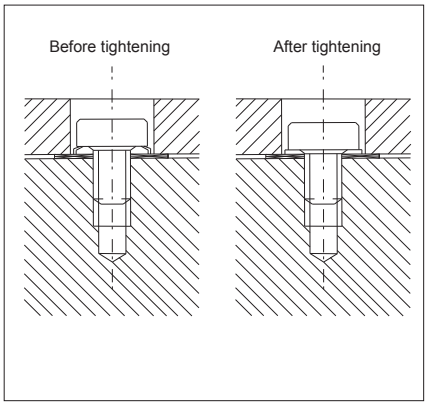
The armature plate is opposed to the shaft, and the coaxiality and perpendicularity of the armature should not exceed the allowable value, then assemble it correctly.

Unit : (mm)

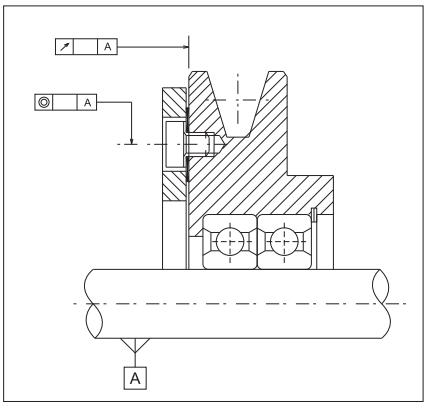
Specifications (kg/m)	0.6	1.5	2.5	5.0	10.0	20.0	40.0
Coaxiality (T.I.R)	0.16	0.16	0.16	0.16	0.16	0.24	0.24
Verticality (T.I.R)	0.04	0.05	0.05	0.06	0.07	0.11	0.11



Armature Installation



Usage of spring sheet



Installation accuracy

Design and adjustment of clearance

◆ The Setting of Clearance "a"

In order to keep the clearance "a", need to prepare a washer shorter than the necessary length R in advance, use pads to adjusted the remaining clearance to ensure that "a" is at the specified value. At this time, the length of washer is determined by the following formula generally:

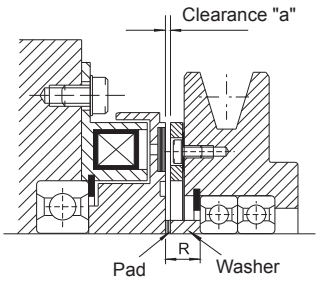
$$L=R-2a(mm)$$

L: Length of washer

R: The necessary length to keep "a"

a: Specified value of clearance

The value of "L" obtained by this formula is the standard value, and prepared a washer which has easy-to-machining length. Design as this, after long-term used, just need to move out a necessary number of washers when adjusting the clearance.

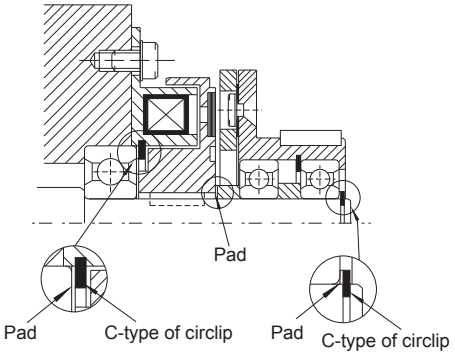


◆ Remove "Gap" of shaft direction

Clutch/brake and components used in assembling, once there is a "gap" in the shaft direction after assembling, which may cause damage to the performance of clutch/brake, so please design the "gap" as small as possible.

Washers are designed to suppress some "gaps" in the shaft direction, we have prepared a variety of washers, especially those which will match with the outer dimension of shaft diameters and bearing that more often used.

In addition, combined washer and C-type circlip, the spring effect of the circlip will be brought into full play and be effectively tightened.



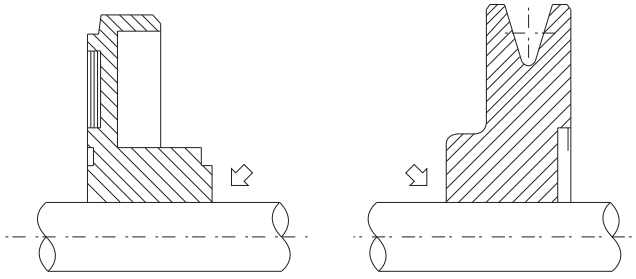
Fit tolerance

Clutch/brake requires not only great work in an instant, but also high precision control. So, in order not to cause wear and vibration of components and affect accuracy, appropriate integration is necessary. Then, according to the conditions of usage, it is necessary to determine the fit tolerance (grade).

◆ Fit tolerance of Rotor/ H-type or N-type of Armature and V-skin Pulley and Shaft

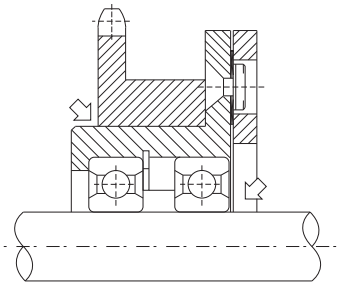
The tolerance of base hole is H7, but the CYT model is the special hole tolerance, the used shaft dimension tolerance is as follows:

Loading condition	Shaft tolerance		Remark
Shaft below Ø10	h6	h7	Required precision h5
Light load, Common load and Fluctuating load	h6		Motor shaft h6 j6
	js6	js7	Shaft of clutch/ brake unit is j6
	j6	j6	
Heavy load and Impact load	k6	k7	
	m6		



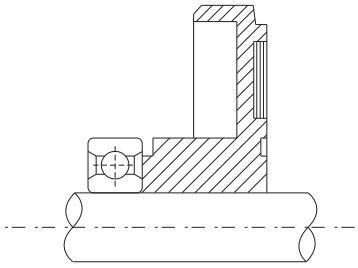
Installation & Design

◆ Fit tolerance between B-type armature and key wheel/ shaft



◆ Fit tolerance between bearings and other components

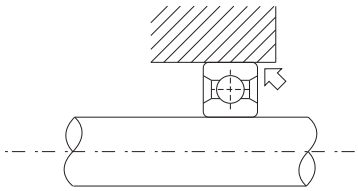
When the bearing, rotor and components such as V-type belt are installed in the same part of the shaft, the shaft grade should give priority to the bearing, please according to the fit tolerance between the ball bearing and the shaft.



◆ Fit tolerance between the ball bearing and sheel.

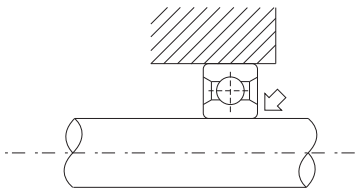
Loading condition		Aperture tolerance	Remark
Outer wheel rotating load	Heavy load	N7	
	Common load and Fluctuating load	M7	
Directional unstable load	Heavy impact load		
	Common load and Heavy load	K7	
	Common load and Light load	J7	
Inner wheel rotating load	Impact load		
	Common load	H7	When clutch/brake not impacted

● It's suitable for the sheel that made of steel or cast iron.
For those which made of light alloy, it is suitable to use a more robust one.



◆ Fit tolerance between the ball bearing and shaft.

Loading condition		Aperture tolerance		Remark
Outer wheel rotating load		h6		Required precision h5
Directional unstable load	Light load, Common load and Fluctuating load	Below Ø18	h5	
		Below Ø100	j6	
Inner wheel rotating load	Common load and Heavy load	Below Ø18	j5	
		Below Ø100	k5	



Aperture & Keyway

◆ Aperture

Standard aperture is determined for all sizes (as showed in the table below) and can be selected.
When using the aperture other than the standard aperture, the rotor, H-type and N-type of armature, as prepared pre-drilling, should machining according to the machine range and the following notes.
The range of machinable apertures is listed in the table below.

①Fit tolerance of aperture should according to the class H7.
②Please pay full attention to the coaxiality and verticality in machining.
③Once the force is applied on the outer part of the rotor, it will engender deformation, so please do not clamp it.
④After machining, remove the cutting oil, cleaning oil, etc. and then install it on the machine after drying.

The machine range of apertures for rator, H-type & N-type of armature.

Unit：(mm)

Clutch/brake model		Aperture																														
		5	6	8	(8.5)	10	12	(12.5)	15	17	(18.5)	20	(24)	25	28	30	32	35	40	48	50	60	70	75	80								
0.6	R																															
	A																															
1.5	R																															
	A																															
2.5	R																															
	A																															
5.0	R																															
	A																															
10.0	R																															
	A																															
20.0	R																															
	A																															
40.0	R																															
	A																															

N The number inside () denote pre-drilling (pre-drilling uncompleted finishing)
R : Denote rotor
A : Denote H-type/N-type of armature

Denote standard aperture
Denote possible range

Selection Reference Table of Model

Two types of Clutch operating conditions

Ⅰ Adding load after the start-up is completed (e.g. cutting after the lathe has been machined to a certain speed)
Ⅱ Added load before start-up (e.g. when the wheelbelt starts, the load has connected and started at the same time.)

▶Reference Table Ⅰ：Adding load after the start-up is completed

Motor capacity		r.p.m																				
KW	HP	100	200	300	400	500	600	700	800	900	1000	1100	1200	1500	1800	2000	2400	3000	3600	4000	4600	5000
0.015	1/50																					
0.035	1/20																					
0.065	1/12																					
0.1	1/8																					
0.125	1/6									1.5												
0.2	1/4																					
0.25	1/3																					
0.4	1/2																					
0.55	3/4									2.5												
0.75	1																					
1.1	1½																					
1.5	2									5.0												
2.2	3																					
3.7	5									10												
5.5	7½																					
7.5	10									20												
11	15									40												
15	20																					
19	25									65												
22	30																					
30	40																					
37	50									100												
45	60																					
55	75										200											
75	100																					
92	125																					
110	150																					

▶Reference Table Ⅱ： Added load before start-up

Motor capacity		r.p.m																				
KW	HP	100	200	300	400	500	600	700	800	900	1000	1100	1200	1500	1800	2000	2400	3000	3600	4000	4600	5000
0.015	1/50																					
0.035	1/20																					
0.065	1/12																					
0.1	1/8									1.5												
0.125	1/6																					
0.2	1/4																					
0.25	1/3																					
0.4	1/2									2.5												
0.55	3/4																					
0.75	1									5.0												
1.1	1½																					
1.5	2									10												
2.2	3																					
3.7	5									20												
5.5	7½									40												
7.5	10																					
11	15									65												
15	20									100												
19	25																					
22	30									200												
30	40																					

Calculation formula for Selection

Torque calculation

$$T=\frac{9550P}{N}=\frac{7017P'}{N}=\frac{7154P''}{N}$$

Calculation of Average Dynamic Friction Torque

1. Load-free Torque： $Tac(or\ Tab)=\frac{J\cdot Nr}{9.55\ tac(or\ tab)}$

2. Load Torque
   - Start-up acceleration： $Tac=\frac{J\cdot Nr}{9.55\ tac}+TL$
   - Deceleration stop： $Tab=\frac{J\cdot Nr}{9.55\ tab}-TL$

The calculation of action time

1. Load-free Torque： $Tac=Tab=\frac{2\pi\cdot J\cdot Nr}{60Td}=\frac{J\cdot Nr}{9.55\ td}$

2. Load Torque
   - Start-up acceleration： $Tac=\frac{2\pi\cdot J\cdot Nr}{60(Td-TL)}=\frac{J\cdot Nr}{9.55(Td-TL)}$
   - Deceleration stop： $Tab=\frac{2\pi\cdot J\cdot Nr}{60(Td+TL)}=\frac{J\cdot Nr}{9.55(Td+TL)}$

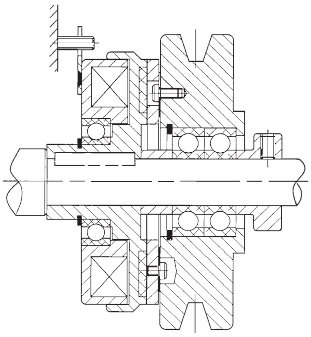
Symbolic Description

- T: Torque (N・m)
- TL: Load torque (N・m)
- Td: Dynamic friction torque of clutch/brake (N・m)
- P: Output power of prime motor (kw)
- P': Output power of prime motor (HP)
- P": Output power of prime motor (PS)
- N: Shaft speed of clutch/brake (r/min)
- Nr: Shaft relative speed of clutch/brake (r/min)
- Tac(Tab): Actual connection time of clutch/brake (S)
- Tac(Tab): Average dynamic friction torque of clutch/brake (N・m)
- J: The sum of the converted inertia moment of the clutch/brake shaft of the system (kgm²)

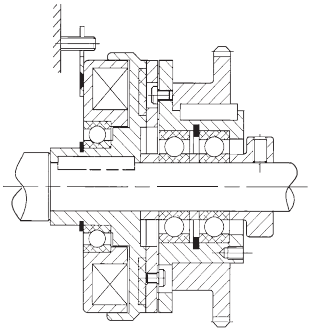
Installation of Electromagnetic Clutch & Brake

Installation

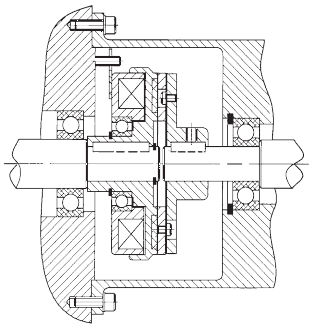
Clutch MCS
Install the armature to the V belt directly



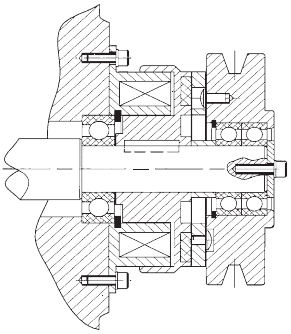
Clutch MCS-1
Install the sprocket bearing to the pedestal



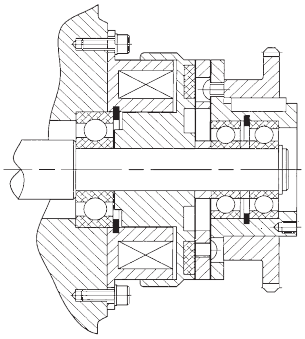
Clutch MCS-2
Keep pedestal to slip shaft installed and
pay attention to the concentricity and verticality



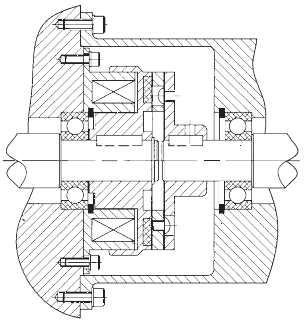
Clutch FCD
Install the flange to the wall and
install the armature to the V belt directly



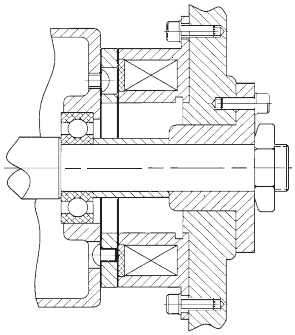
Clutch FCD-1
Install the flange to the wall and
install the sprocket bearing to the pedestal



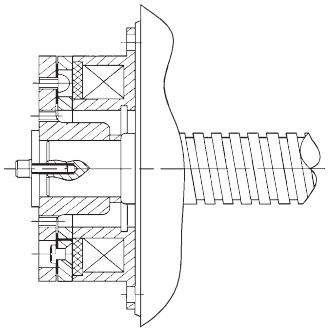
Clutch FCD-2
Keep pedestal to slip shaft installed and
pay attention to the concentricity and verticality



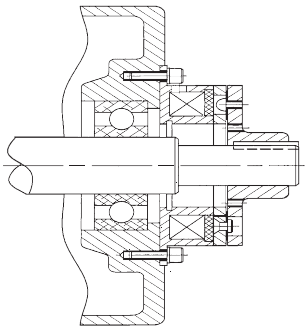
Brake FBD
Coil body flange is fixed to the holder



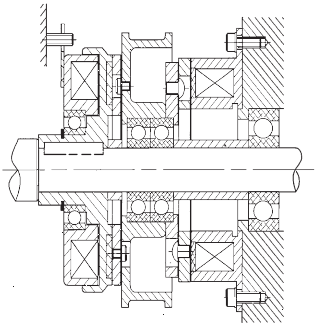
Brake FBD-1
Installed at shaft end and guide seat flange inward



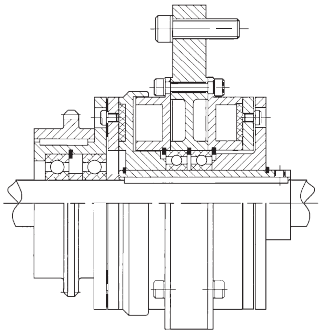
Brake FBD-2
Installed at shaft end and guide seat flange outward



Clutch/Brake MCS-FBD
Combination mounted on both sides of belt



Clutch/Brake FCD-FBD
Combination mounted on both sides of holder



2x Clutch FCD-FCD
The combination is mounted on the through shaft,
and can be used for positive and negative shafts
and variable speed, etc.