YASKAWA ELECTRIC

INSTRUCTIONS
TOE-C411-10B

MEDIUM SIZE AIR-COOLED VS MOTORS

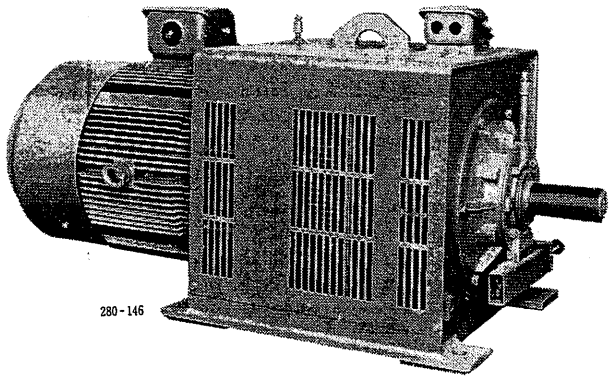
Indoor Use Type VBOMN
Outdoor Use Type VBOMN-O
45-250kW

Before initial operation read these instructions thoroughly, and retain for future reference.

報九 保管

BEFORE STARTING

When properly installed, operated and maintained, this equipment will provide a lifetime of optimum operation. Before starting read thoroughly these instructions, and keep them for future reference.



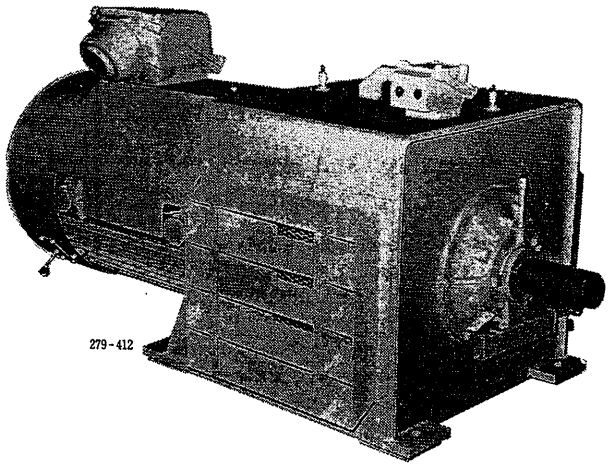
Indoor Type VBOMN

RECEIVING

This motor has been put through severe tests at the factory before shipped. After unpacking, however, check and see the following.

- Its nameplate rating meets your requirements.
- After removing the thrust block from the output shaft, turn the shaft by hand to ascertain that it rotates freely.
- It has sustained no damage while in transit.
- Bolts and screws are not loose.

If any part of the unit is damaged or lost, immediately notify us giving full details and nameplate data.



Outdoor Type VBOMN-O

CONTENTS

HANDLING

Use the suitable method of handling the motor according to its weight indicated on the nameplate. Be sure to attach a thrust block to the shaft before handling.

For lifting the motor with a crane, use lifting hooks or eye(s) on frame. The motor must be disconnected from the driven machine and power supply before lifting.

STORAGE

If the unit is not to be installed immediately, it must be stored in a clean, dry indoor place below 40°C and protected from high humidity, corrosive gases and liquids, and be free of ambient vibration. Apply the thrust block. Motor should be loosely covered with a tarpaulin plastic cover or similar type of protective cloth.

When placed in storage or prolonged shutdown for a period in excess of THREE MONTHS, hand-rotate the output shaft every three months to redistribute bearing grease and to prevent bearings from becoming brinelled.

INSTALLATION

LOCATION

Install in a clean, dry place below 40°C free from corrosive (explosive) gases and liquids, and vibration.

MOUNTING COUPLING AND SHEAVES

Mount the couplings and sheaves in the following procedure.

1. Remove the key from shaft extension and wash out anticorrosive paint on the key and shaft extension with thinner or light oil.
2. If any burr or scratch is found on the key, remove it with a file. Proper fitting of the key:
   - Requires light hitting when mounting on the shaft extension.
   - Allows the key to move axially by hand in the keyway of the boss of the coupling or V-belt sheave.
3. Paint lightly the entire surface of shaft extension with antiseizure agent containing a molybdenum disulfide. Yaskawa employs "Molykote G Paste" made by DOW CORNING CORP., U. S. A.
4. Expand the boss of coupling by heating with a torch or heater. See Fig. 1.

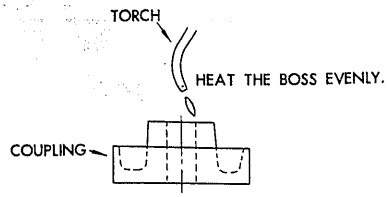


Fig. 1 Heating of Coupling for Shrinkage Fitting

5. After heating, locate the coupling or V-belt sheave in place on the shaft quickly. Do not blow them too strong with a hammer, or bearings will become damaged.
6. If the shaft does not rotate freely or makes a clicking sound, mounting may not be proper. The motor must be removed and inspected.
7. Setscrew, if used, should be mounted after the temperature of boss regains the temperature 40°C or below.

FOUNDATION AND MOUNTING PLATES

Motors should be set on the mounting plate (bed, base, soleplate or slide rails) installed on the foundation. The foundation must be solid and rigid enough to sustain machine weights or shocks during operation. Concrete (reinforced as necessary or required) makes the best foundation, particularly for large motors and driven units. In sufficient mass it provides rigid support that minimizes deflection and vibration. The concrete foundation surface should be roughly leveled when grouting. The mounting plates (or motor) should be correctly leveled by using a spirit level and shims when coupling to the driven machine.

For V-belt drives, the motor will be mounted on a single or two slide rails. When two slide rails are used, leveling must be made as to each rail first, and then on two rails putting a straightedge across the rails and setting the spirit level on it as shown in Fig. 2. It is important that the level check be made with all foundation bolts tightened securely. For level adjustment, use a few thick shims rather than a large number of thin shims.

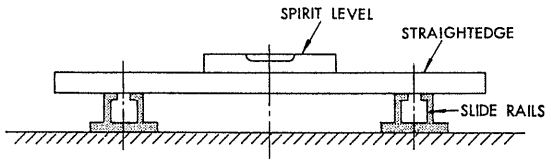


Fig. 2 Leveling across Two Slide Rails

ALIGNMENT

True alignment of motor and driven machine is essential to prevent vibration, short bearings and coupling life, or shaft and bearing failures. Before grouting the base, the alignment should be checked as follows. Be sure that every level check is made with all hold-down bolts and foundation bolts tightened.

DIRECT DRIVE (Fig. 3)

Align the motor and driven machine as follows.

ROUGH ALIGNMENT

Check roughly the radial alignment by using a straightedge. Place the straightedge across the coupling halves of top, bottom and both sides as indicated in Fig. 3 (a) and (c), and detect visually any gap between the straightedge and coupling halves. Correct misalignment, if any, by shimming between the base and the machine or foundation, or move the motor until no gap is observed. This rough alignment facilitates the fine alignment described below.

ACCURATE ALIGNMENT

Offset misalignment

Check for offset misalignment, Fig. 3 (b). Set a dial indicator to one coupling half and place the indicator finger tip against outside diameter of the other coupling half. Then rotate both coupling halves together keeping the finger tip on the coupling. Read the indicator at four points—top, bottom and both sides—of the coupling as shown in Fig. 3 (c). Be sure that the dial-indicator supports do not bend or sag, since this will give inaccurate readings. The value of distortion must be deducted from the value measured. See Fig. 4.

If the reading difference between top and bottom exceeds the values shown in Table 1, correct the alignment by shimming, and between right and left sides, by moving the base or the motor. Alignment is satisfactory when these difference do not exceed the values in Table 1.

ANGULAR MISALIGNMENT

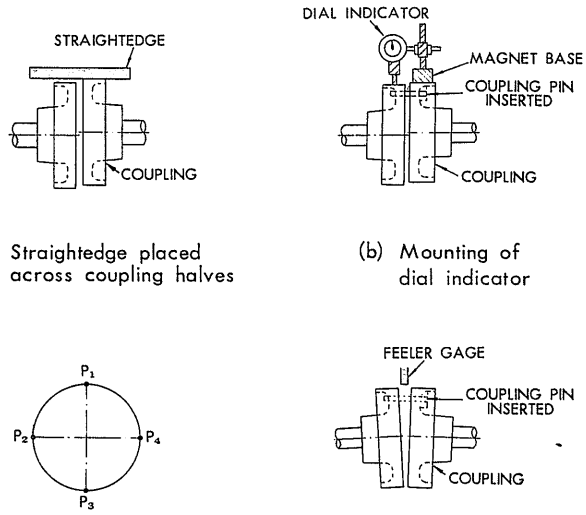
Check for angular misalignment as illustrated in Fig. 3 (d). Insert a feeler gage between the coupling faces and rotate both coupling halves simultaneously. Note the feeler gage readings at four equidistant points as shown in Fig. 3 (d). The maximum variation between any two readings should not exceed values in Table 1. If difference is larger than those, correct the alignment by shimming under the base or the machine.

Table 1 Allowable Tolerances on Offset and Angular Misalignment

Tolerances in mm

Coupling	Speed rpm	Offset Tolerance	Angular Tolerance	
			Coupling dia up to 400	Coupling dia 400 to 600
Flexible Coupling	1300 - 1800	0.025	0.05	0.07
	Below 1300	0.040	0.08	0.10
Rigid Coupling	Below 1800	0.015	0.03	0.03

After the motor has been aligned completely, make sure that the motor is bolted down solidly to the base and the base to the foundation. If any loose bolts are found, set them tight and recheck the alignment repeating steps for offset and angular misalignment described above.



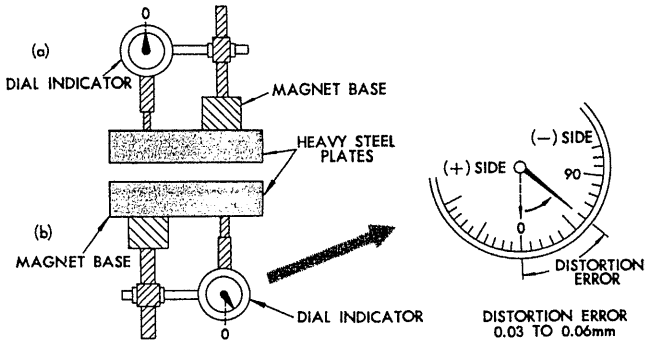
(a) Straightedge placed across coupling halves

(b) Mounting of dial indicator

(c) Four positions at which measurements are taken by dial indicator and feeler gage

(d) Using feeler gage to check angular alignment

Fig. 3 Alignment of Coupling for Direct Drive



DISTORSION ERROR

Procedure for measurement of distortion error:

1. Mount the indicator on heavy steel plate. See Fig. 4 (a).
2. Set back the indicator needle to zero.
3. Read the inidicator upside-down. See Fig. 4(b). The reading indicates the distortion error.

Thus, when error is induced, actual value can be obtained as follows.

Actual value = (Reading) - (Distortion error)

Example:

Distortion error: -0.06 mm
Reading: +0.03 mm

+0.03 - (-0.06) = 0.09 ··· Actual value

Fig. 4 Measurement of Distortion Error

V-BELT DRIVE (Fig. 5)

Setting the Slide Rails

For V-belt drive, the motor is mounted on slide rails. Level the slide rails as described in FOUNDATION AND MOUNTING PLATES, page 2.

Parallelism

Mount the motor on the leveled slide rails so that the shafts of motor and driven machine are parallel to each other, and align the sheaves. To check alignment of two sheaves, apply a piano wire, stretching tautly as shown in Fig. 5 and determine if four points a, b, c and d are in line.

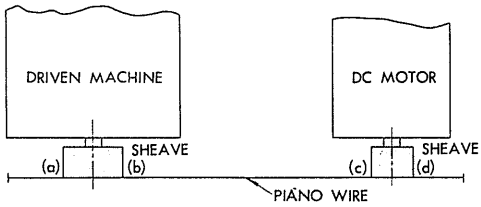


Fig. 5 Checking Alignment of Two Sheaves with a Piano Wire

V-Belt Tension Adjustment

Adjust the V-belt tension to just prevent slippage when the motor is running at full-load and accelerated. And too tight V-belt may cause not only rapid wear of the belt but also undue stress to the machine shafts, resulting in shorter bearing life and shaft damage. Adjustment shown in Table 2 is a suggested way to obtain the proper belt tention.

1. Determine the belt span on the slack side of the drive. The span is the length of the belt between the points at which the belt leaves the sheaves, and not the center distance of two shafts. If two sheaves are the same in diameter, the span is equal to the shaft center distance. See Fig. 6.

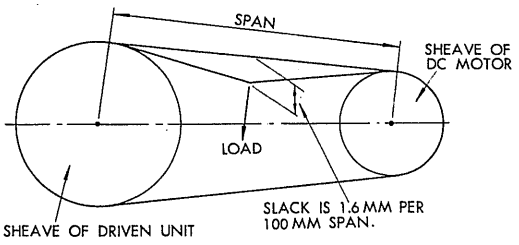


Fig. 6 Belt Span and Center Distance of Two Sheaves

2. Obtain the midpoint of the span. One suggested way is to take the span on a string and fold the spring in two. Apply a spring balancer to the midpoint of the belt. Then pull the belt inwards at right angle to the belt until the slack becomes 1.6 millimeters per 100 millimeters, and register the balancer reading. Where the span is 500 millimeters, for example, the slack required will be obtained by the equation below:

$$\frac{500}{100} \times 1.6 = 8 \text{ (required slack in mm)}$$

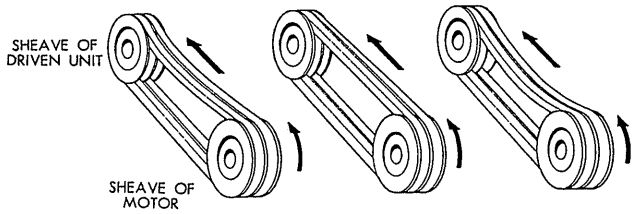
3. Adjust the belt tension so that the spring balancer reading is between the maximum and minimum values in Table 2. To shift the motor on the rails for tension adjustment, turn the adjusting screw on the slide rails. Set firmly the mounting bolts of the motor upon completion of adjustment.

Table 2 Load to Obtain Proper V-Belt Tension

Nominal Output kW	Pole	Conventional V-Belt							Narrow V-Belt						
		Type	No. of Belts	Sheave Dimensions in mm		Tension Load per V-Belt (kg)		Output Shaft Load (kg)	Type	No. of Belts	Sheave Dimensions in mm		Tension Load per V-Belt (kg)		Output Shaft Load (kg)
				Pitch Dia	Width	When Replacing	When Readjusting				Pitch Dia	Width	When Replacing	When Readjusting	
45	4	C	6	265	162	4.5-5.1	3.5-4.5	596	5V	4	224	78	6.3-7.2	4.9-6.3	702
	6	C	7	280	187	4.6-6.2	3.5-4.6	707	5V	6	224	113	6.0-6.9	4.7-6.0	795
55	4	C	7	265	187	4.6-5.3	3.6-4.6	719	5V	5	224	96	6.2-7.1	4.8-6.2	675
	6	C	8	300	213	4.6-5.3	3.6-4.6	823	5V	6	250	113	6.0-6.9	4.7-6.0	871
75	4	C	8	300	213	5.1-5.9	4.0-5.1	916	5V	6	250	113	6.4-7.3	5.0-6.4	840
	6	D	6	355	233	7.9-9.0	6.2-7.9	1042	5V	7	280	131	6.6-7.6	5.1-6.6	1070
90	4	Use Narrow V-Belt.							5V	6	280	113	7.0-8.1	5.4-7.0	914
	6								5V	7	315	131	6.9-7.9	5.4-7.4	1152
110	4								5V	7	280	131	7.3-8.4	5.6-7.3	1112

Notes: 1. Output shaft load is average radial load by V-belt tension.
2. Table values are complied with JEM (The Standard of Japan Electrical Manufacturer's Association).

4. After adjustment of belt tension, operate the drive a couple of minutes to see if belt tension has been set properly. An optimum belt tension gives a slight bow on the top (slack side) while the drive is started and operating at full load, as shown in Fig. 7 (a). Too tight belt gives no bow as illustrated in Fig. 7 (b), and too slack belt produces a large bow, Fig. 7 (c).



(a) Proper tension (b) Excessive tension (c) Insufficient tension

Fig. 7 Belt Tension and Running Direction

Readjustment

The V-belt requires several days of operation to cosily adjust themselves. Be sure to check the belt tension after several days of operation and once a month after the drive has been put into operation.

WIRING

Securely make the lead connections, referring to the motor nameplate for power supply requirements and to the connection diagram of the drive, since defective wiring causes motor burnout or damages controllers.

FOR PRIME MOVER (INDUCTION MOTOR)

Tables 3 and 4 show the size of rubber or plastic power lead (copper conductors) used for VS motor.

Table 3 Lead Size for Motors 600 VAC or Below

Number of Motor Leads	VS Motor Nominal Output kW		Sectional Area mm^2 (Single Core Lead)
	200 V Class	400 V Class	
6	-	75	50
	45, 55	90 - 132	100
	-	100, 200	150

Table 4 Lead Size for Motors Exceeding 600 VAC

Number of Motor Leads	VS Motor Nominal Output kW	Sectional Area mm^2 (3-Core Lead)
3	45 - 132	14
	160, 200	22.
	250	30

IMPORTANT

1. Where J and K press terminals for exciting power supply are replaced, strip the transparent sheath under the black sheath at the end of wire and mount new press terminals.

2. To protect excitation coil of VS coupling, connect VS controller power supply by using time-delay relay so that two or three seconds after prime mover has started the controller power supply turns ON.

3. Where the main circuit power supply is separate from the control circuit source, provide interlock so that VS controller is turned on after the closure of magnetic starter for main circuit.

4. Insulation resistance of prime mover, VS coupling and tachometer generator should be over the values in Table 5. To make Megger test of VS coupling remove the leads connected to terminals 3 and 4 and use the disconnected leads. For tachometer generator, use the leads to terminals 5 and 6_{50} (or 6_{60}) after disconnecting them.

Table 5 Measurement of Insulation Resistance

Component		Megger	Resistance
Prime Mover	Low Voltage	500 V	3 MΩ or above
	High Voltage	1000 V	10 MΩ or above
VS Coupling		500 V	3 MΩ or above
Tachometer Generator		500 V	1 MΩ or above

PRIME MOVER CONNECTION

Connect power leads to prime mover leads as shown in Fig. 8. Connection diagram is attached to the inside of terminal box cover.

For connections to magnetic starter, refer to the instructions for magnetic starter.

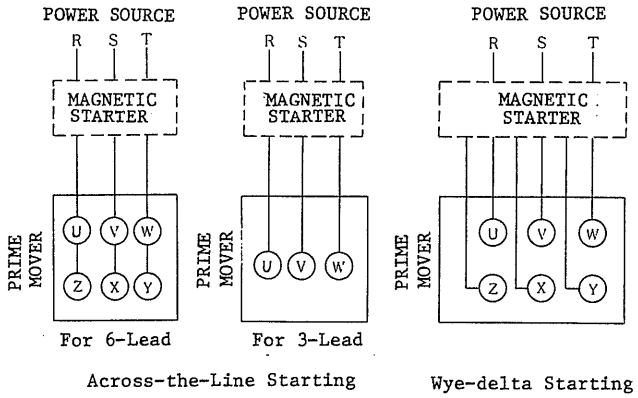


Fig. 8 Connections for Prime Mover

DIRECTION OF ROTATION

The standard direction of rotation is counterclockwise viewing from the drive end. To reverse the direction, interchange any two of line leads.

VS COUPLING AND TACH-GEN CONNECTIONS

SIZE OF LEADS

Use the lead 2 mm^2 and above for the excitation coils of VS coupling, for tachometer generator, 0.75 to 2 mm^2. The terminal fastening screw is M4.

CONNECTIONS

Connect the terminals of VS coupling and VS controller shown in Fig. 9. Wiring must be made correctly since defective wiring causes tachometer generator burnout and demagnetization.

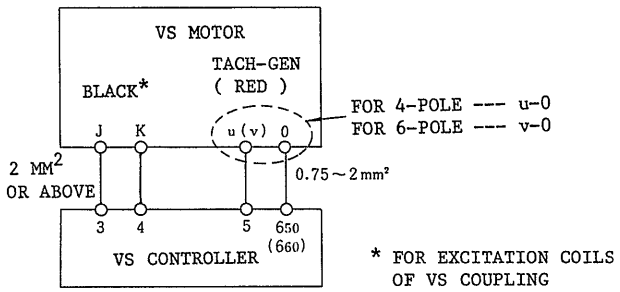


Fig. 9 Connections of VS Coupling and VS Motor Controller

OPERATION

BEFORE PUTTING INTO SERVICE

Check the following items.

1. Make sure that thrust block is removed.

2. Disconnect VS coupling from load, if connected.

3. The shaft should be clear of any obstructions for rotating.

4. Be sure that wiring is correct and screw is tightened up on each terminal.

5. Insulation resistance of prime mover and VS coupling should be the values shown in Table 5.

IMPORTANT

BEFORE MEGGER TEST OF VS COUPLING, DISCONNECT IT FROM VS CONTROLLER. IF NOT, VS CONTROLLER MAY BE DAMAGED.

6. Leads and coils should not be shortcircuited.

When VS motor is to be operated after storage for 3 months or more, replenish bearings with grease, referring to "MAINTENANCE."

TEST RUN

Refer to the instructions for VS controller.

1. The actual outputs of VS motors are at the rated maximum speed. See Tables 6 and 7.
2. Operate VS motor within the rated speed or VS motor cannot be accurately controlled and may go wrong.
3. Where the load torque is 10% or below, VS motor cannot be accurately controlled.
4. Speed regulation is adjustable 1 to 20% by using of the VS controller type H or HS when torque load is 10 to 100%, for type ES, 2 to 20%.
5. When SPEED SETTING is set to LOW at no load, the wind pressure of prime mover may cause the output shaft of VS motor to rotate slowly, but this does not cause any trouble.

Table 6 Speed Range and Output of Constant Torque VS Motor

Nominal Output kW	Pole	Rated Output kW	Rated Speed Range rpm	
			50 Hz	60 Hz
45	4	39	1350 - 135	1650 - 165
	6	37	850 - 425	1050 - 525
55	4	48	1350 - 135	1650 - 165
	6	45	850 - 425	1050 - 525
75	4	65	1350 - 450	1650 - 550
90	4	78	1350 - 675	1650 - 825

Table 7 Speed Range and Output of Variable Torque VS Motor

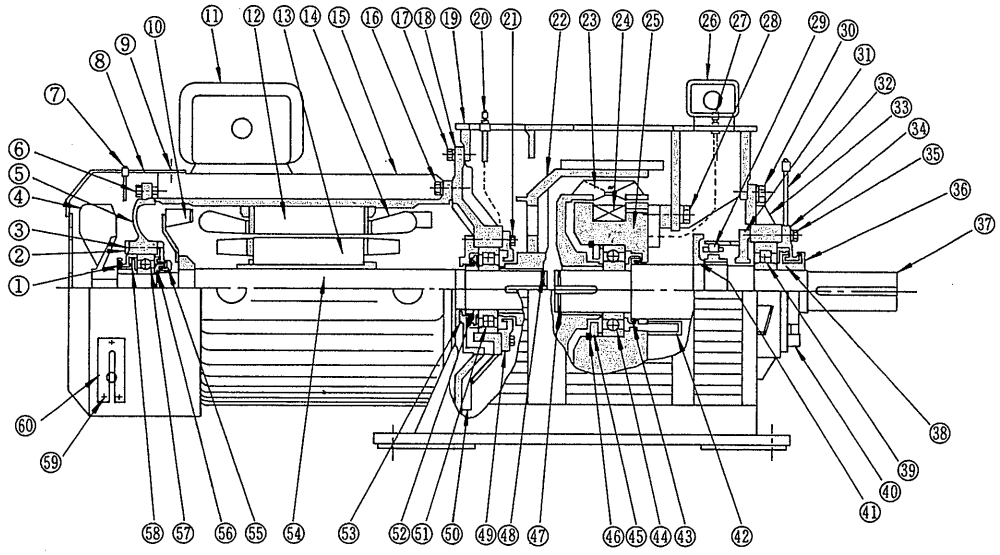
Nominal Output kW	Pole	Rated Output kW	Rated Max Speed rpm	
			50 Hz	60 Hz
45	4	39	1350	1650
	6	37	850	1050
55	4	48	1350	1650
	6	45	850	1050
75	4	65	1350	1650
	6	62	850	1050
90	4	78	1350	1650
	6	73	850	1050
110	4	93	1350	1650
	6	90	850	1050
132	4	112	1350	1650
	6	105	850	1050
160	4	135	1350	1650
	6	130	850	1050
200	4	170	1350	1650
250	4	215	1350	1650

MEMO

DISASSEMBLY AND REASSEMBLY

Before disassembling, observe the following.

- Disassemble or reassemble VS motor in a clean and dry place free from water drops.
- Keep small parts such as screws so that they should not be missed for reassembling.
- Rest the disassembled parts on clean wooden board, paper or cloth.
- Care should be taken to avoid damage to the bearing. Do not blow bearing outer race with a hammer or apply undue stress to the bearing.



① FRINGER (OUTDOOR TYPE ONLY)
② BEARING COVER
③ BEARING COVER MTG NUT
④ EXTERNAL FAN
⑤ BRACKET
⑥ BRACKET MTG BOLT
⑦ GREASE NIPPLE
⑧ FAN COVER
⑨ FAN COVER MTG BOLT
⑩ INTERNAL FAN
⑪ TERMINAL BOX FOR PRIME MOVER
⑫ STATOR
⑬ ROTOR
⑭ STATOR COIL
⑮ PRIME MOVER FRAME
⑯ BRACKET MTG BOLT
⑰ PRIME MOVER MTG BOLT
⑱ BRACKET
⑲ VS COUPLING FRAME
⑳ GREASE NIPPLE
㉑ BEARING COVER MTG BOLT
㉒ DRUM
㉓ INDUCTOR
㉔ EXCITATION COIL
㉕ YOKE
㉖ TERMINAL BOX FOR VS COUPLING AND TACH-GEN
㉗ GREASE NIPPLE
㉘ YOKE MTG BOLT
㉙ TACH-GEN
㉚ BRACKET MTG BOLT
㉛ BEARING COVER
㉜ GREASE PIPE
㉝ BRACKET
㉞ BEARING COVER
㉟ BEARING COVER MTG NUT
㊱ FRINGER (OUTDOOR TYPE ONLY)
㊲ OUTPUT SHAFT
㊳ GREASE VALVE
㊴ DRIVE END BEARING FOR VS COUPLING
㊵ GREASE DISCHARGER
㊶ FRINGER
㊷ GREASE GUTTER
㊸ BEARING SEAL
㊹ OPP-DRIVE END BEARING FOR VS COUPLING
㊺ BEARING COVER
㊻ SNAP RING
㊼ SNAP RING
㊽ SNAP RING
㊾ BEARING COVER
㊿ GREASE DRAIN PORT
(51) INNER BEARING FOR PRIME MOVER
(52) GREASE VALVE
(53) BEARING COVER
(54) PRIME MOVER SHAFT
(55) BEARING COVER
(56) BEARING SEAL
(57) EXTERNAL BEARING FOR PRIME MOVER
(58) GREASE VALVE
(59) GREASE DISCHARGER COVER MTG BOLT
(60) GREASE DISCHARGER COVER

Fig. 10 Construction of VS Motor

DISASSEMBLY OF VS COUPLING

IMPORTANT

- Do not remove the yoke mounting bolts (28) except for replacing the excitation coil.
- Store the tach-gen rotor (29), if removed, in the tach-gen stator.
- Where two or more VS motors are disassembled, tach-gen rotors should be separate.

1. Remove VS motor from the drive machine.
2. Disconnect the leads for VS coupling, prime mover and tachometer generator after scribing a tram mark on the leads.
3. Transfer VS motor to a proper disassembly shop.
4. Pull out the coupling or V-sheave on the output shaft extension.
5. Remove the socket and nut of grease nipple (20).
6. Loosen the prime mover mounting bolts (17) and take out the prime mover with drum (22) from VS coupling.
7. Pull out the fringer (36) (for only outdoor type).
8. Remove the bearing cover mounting nuts (35) and take out the bearing cover (34).
9. Loosen the grease valve setscrew and pull out the grease valve (38) from the output shaft (37).
10. Loosen the bracket mounting bolts (30) and take out the bracket (33).
11. Pull out the drive end bearing for VS coupling (39).
12. Remove the bottom plate of the terminal box (26) and pull out the leads one by one from the rubber bushing.
13. Pull out the bearing cover (31) with the tachometer generator stator (29).
14. Loosen the tachometer generator rotor setscrew and pull out the rotor. Do not hear it.
15. Pull out the fringer (41) (for only outdoor type).
16. Remove the snap ring (47).
17. Pull out the inductor (23).
18. Remove the snap ring (46).
19. Pull out the bearing cover (45).
20. Pull out the output shaft (37) from the opposite drive end.
21. Pull out the opposite-drive end bearing for VS coupling (44).
22. Remove the grease nipple (27) and detach the tube from the grease pipe on VS coupling frame.
23. Loosen the yoke mounting bolts (28) and detach the yoke (25).

DISASSEMBLY OF PRIME MOVER

1. Remove the socket and nut of grease nipple (20).
2. Loosen the mounting bolts (17) and remove the prime mover with the drum (22) from VS coupling.
3. Remove the snap ring (48).
4. Pull out the drum (22).
5. Loosen the mounting nuts (21) and remove the bearing cover (49).
6. Loosen the mounting bolts and remove the bracket (18).
7. Pull out the bearing (51).
8. Loosen the mounting bolts (59) and remove the grease discharger cover (60) and pull out the discharging rod.
9. Loosen the pipe of grease nipple (7) and pull it out.
10. Loosen the mounting bolts (9) and remove the fan cover (8).
11. Loosen the external fan setscrew and remove the external fan (4).
12. Loosen the fringer setscrew and pull out the fringer (1) (for outdoor type only).
13. Loosen the mounting nut (3) and remove the bearing cover (2).
14. Loosen the mounting bolts (6) and remove the bracket (5).
15. Loosen the grease valve setscrew and pull out the grease valve (58).
16. Pull out the bearing (57).

REASSEMBLY

Reassemble VS motor in the reversing order of disassembly, keeping in mind the following:

- Protect the new bearing from dust.
- Care should be taken to avoid damage to the bearing outer race with a hammer or apply undue stress to the bearing.
- When reassembling the inductor to the shaft, heat the inductor evenly.

MAINTENANCE

Routine, regular maintenance is the best assurance of trouble-free, long-life operation. It prevents costly shoutdown and repairs.

Essentially maintenance of VS motors centers about the *BEARINGS* and *WINDINGS*. Rotors require little or no special care in normal service, except to make contain that bolts or other fasteners remain tightly secured.

BEARING

SEALED BEARING (Type 6312LLB(VV))

This bearing is filled with lithium base wide range grease prior to shipment and cannot be regreased. Replace bearing once every three or four years.

For the bearing number, refer to the VS motor nameplate. Use a lithium based wide-range grease. YASKAWA utilizes Maltemp SRL-3 made by KYODO OIL Co., Ltd., Japan.

REGREASABLE BEARING

Use a lithium base multipurpose grease. YASKAWA utilizes Sun Light EM-3 made by SHOWA OIL Co., Ltd., Japan.

Lubrication Requirements

Regreasable bearing lubrication requirements vary with bearing operating temperature, operating and atmospheric conditions. Table 8 is offered as a guide. For bearings use at temperature exceeding or below 80°C, greasing intervals determined by referring to the note of Table 8.

Table 8 Lubrication Intervals (at Bearing Temperature 80°C)

Bearing No.		Speed (rpm)			
Deep Grease Bearing	Cylindrical Roller Bearing	720 or below	720 to 900	900 to 1200	1200 to 1800
6312	-	Every 7000 hours of operation			
6314	-				
6315	-				
6316	-			Every 5000 hours of operation	
6318	NU314				
-	NU316	Every 5000 hours of operation		Every 3000 hours of operation	
	NU318				
	NU320				

Note: Multiply the coefficients of the right to the table values to determine grease feeding intervals for bearings operating at the temperature other than 80°C.

Bearing Temperature	60°C	70°C	80°C	90°C	95°C
Coefficient	2.50	1.59	1.00	0.63	0.50

Grease Volume

Volume of grease to be added is dependent on the bearing type and size. Table 9 indicates a guide to grease volume for various types of bearings.

Table 9 Grease Volume for Lubrication

Deep Groove Ball Bearing	Cylindrical Roller Bearing	Regreased Volume (g)
6312	-	60
6314	NU314	80
6315	-	90
6316	NU316	100
6318	NU318	120
-	NU320	160

Regreasing

With the motor running, add grease from the grease nipple using a grease gun. Greasing with the motor at standstill will not completely expel the old grease.

When new grease is added, the bearing temperature will rise but it will come down to the normal remperature after a while. For the bearings (44) and (51), used grease deposits inside the frame since the grease drain parts are not supplied.

Grease Gun

A hand-operated high-pressure grease gun is recommended, since it provides fast and positive greasing.

Replacement of Bearings

IMPORTANT

- Do not handle the bearing with bare hands to prevent rust.
- After shrinkage fitting of bearing, wrap the bearing with clean paper to protect it from dust.
- Bearing should be cooled naturally. Do not use compressed air or fan for cooling.

To remove the bearing, a gear puller may be used. Hook a puller between bearing and bearing cover or on bearing cover.

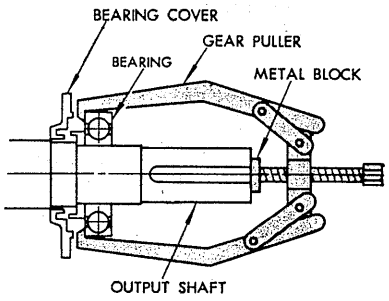


Fig. 11 Removal of Bearing

Mounting of Bearings

- Before mounting, apply thin coat of grease to the VS motor output shaft.
- Apply grease to the labyrinth section of inside bearing cover.

For sealed bearings

For fitting a new bearing, shrinkage fit is recommended. The bearing is heated in a frame as shown in Fig. 12. The frame should have a cover so that the bearing can be heated evenly in it. The bearing, when heated to 80 - 100°C (176 - 212°F) (NEVER EXCEED 100°C), should be quickly shrunk on the shaft. If the bearing temperature drops during mounting and the bearing cannot be slid onto the shaft until it contacts the shaft shoulder, give even blows to the inner race of bearing with hammer. In this case avoid giving localized shocks or pressure to the bearing outer race.

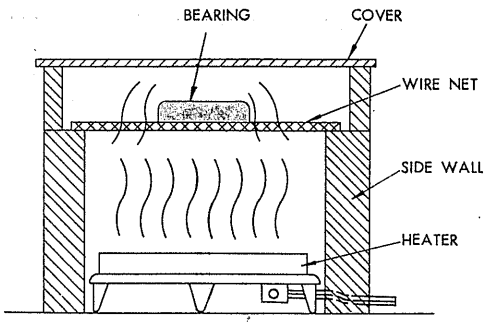


Fig. 12 Heating of Sealed Bearings

For regreasable bearings

1. Heat the bearing to 90 - 110°C in an oil bath, Fig. 13.
2. Mount the bearing quickly and tightly against the shaft shoulder.
3. After the bearing has cooled, feed the grease specified. The bearing should be packed 80% full with grease.
4. Make sure that bearing outer race rotates smoothly by handrotating.
5. Wrap the bearing with clean paper.

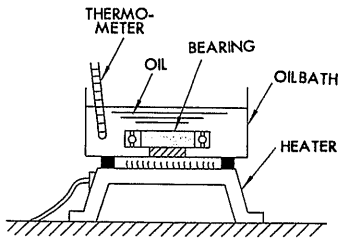


Fig. 13 Heating of Regreasable Bearings

Bearing Temperature

Since the lithium base grease is employed, permissible bearing temperature is 95°C (40°C ambient temperature plus 55°C temperature rise).

WINDINGS

For long life, keep windings clean and dry. Dirt or dust can be removed by wiping with clean cloth, by blowing with clean, dry, low-pressure air or by vacuum cleaner.

The operating temperature of the motor should be checked at regular intervals.

The best indication of the condition of the insulation is a record of the insulation resistance taken at regular intervals when the motor is hot.

INDUCTION MOTOR COIL

Maximum allowable temperature of the induction motor is 155°C (class F insulation). If the insulation resistance decreases 3 MΩ or below for low-voltage (10 MΩ for high-voltage), drying or vanish treatment is recommended.

EXCITATION COIL

Maximum allowable temperature of the excitation coil is 155℃ (class F insulation). If the insulation resistance decreases 3 MΩ or below, drying or vanish treatment is recommended.

Measure coil resistance with a tester applied across terminals J and K of VS coupling after disconnecting from controllers. If the measured value is different by more than 20% from the tabulated value in Table 10, it indicates abnormality. In case of wire breakage or shortcircuit, the coil should be replaced with a new one.

Table 10 Excitation Coil Resistance

Nominal Output kW	Pole	Resistance at 20°C (Ω)	
		Low-Voltage	High-Voltage
45	4	11.5	11.5
	6	11.5	11.5
55	4	11.5	11.5
	6	11.5	11.5
75	4	11.5	11.5
	6	11.5	11.5
90	4	11.5	11.5
	6	18	18
110	4	11.5	11.5
	6	17	17
132	4	18	18
	6	17	17
160	4	17	17
200	4	17	16.5
250	4	-	16.5

TACHOMETER GENERATOR

CONSTRUCTION

The stator of tachometer generator is built into the bearing cover, and the stator coil is resin encapsulated. The rotor is made up of a permanent magnet and fixed to the shaft. If the rotor is replaced, the stator should be replaced with a new one.

VOLTAGE GENERATED

Measure voltage generated of the tachometer generator with a tester across terminals 5 and 6_{50} (6_{60}) of VS controller (or terminals 5 and 6 of VS operator).

Table 11 Voltage Generated

Prime Mover	Tachometer Generator	
Pole	Terminal	Voltage Generated
4	u-o	35 VAC at 1800 rpm (30 VAC at 1500 rpm 24 VAC at 1200 rpm)
6	v-o	35 VAC at 1200 rpm (30 VAC at 1000 rpm 24 VAC at 800 rpm)

VIBRATION

Excessive vibration causes damage to bearings and windings. The total amplitude of vibration should not exceed 50 μm at 1800 rpm. If it exceeds that value, refer to Table 12 to remove the cause.

NOISE

Check if any unusual noise changes from previous observations. Noise of VS motor may be caused chiefly by electromagnetism, ventilation, bearings and metal-to-metal contact. Unusual noise during the daily inspection must be eliminated in accordance with Table 13.

TEMPERATURE

Motors operating under normal conditions become quite warm. Although motor surface feels hot to the touch, the motor may be within guaranteed limits, if operated within rated speed stamped on the nameplate and ventilation is not restricted.

FOR VS COUPLING

Temperature of frame may read 75-85°C on the surface. The temperature rise of drum and frame of VS coupling, and the temperature difference between intake and discharge air are approximately proportional to load torque and speed difference between induction motor and VS output. As the shaft speed decreases, the temperature of frame or discharge air becomes higher. However, this is not unusable.

The temperature rise at minimum speed, while dependent on the VS motor output, will be 40 - 70°C for frame and 20 - 70°C for exhausted air (both rarely 100°C). See the test report or consult us for the normal temperature of each part.

DUST

Excessive dust accumulation at inlet, outlet or inside the VS coupling causes serious troubles such as the disturbance of cooling effect and abnormal temperature rise of the motor.

A large deposit of resin powder inside VS coupling will melt into and fill in the gap between drum and inductor, making the speed control difficult. Disassembly and inspection should be made every two years in general, depending on the kind of dust.

Since the induction motor is of totally-enclosed construction, dust cannot enter the motor. However, cleaning is necessary, for the dust collecting on the frame and bracket surface decreases the cooling effect of motor.

Table 12 Inspection Schedule

Component		Inspection Item	Schedule					Inspection or Maintenance Operation
			Daily	Monthly	Yearly	With motor running	With motor at rest	
External Inspection and Cleaning	VS Motor Proper	Vibration	○			○		Feel by hand. If excessive, measure the vibration with a vibrometer. Max. amplitude: 50 μ. Pay attention to variation of vibration.
		Noise	○			○		If unusual magnetic noise is heard, or unusual noise is accompanied with mechanical vibration, searching inspection is necessary.
		Temperature	○			○		One can touch with finger for two seconds (70 - 80°C). If high, measure with a thermometer.
		Ventilation	○			○		Check for clogged window or dust accumulation.
		Bolts		○			○	If loose, tighten with a wrench.
		Cleaning		○			○	Clean the parts without disassembling with compressed air.
	Bearing	Noise	○			○		Check for any intermittent and unusual noise. If excessive, inspect bearing surface and ring for wear.
		Greasing		○		○		Grease with a grease pump.
	Grease Feed Inlet	Damage	○			○		Repair.
	Output Shaft	Shaft and transmission gear	○			○		If vibration and noise are unusual, searching inspection is necessary.
	Terminal Box	Loose cover fastening screws		○			○	Tighten with a driver.
		Deterioration of leads		○			○	Repair leads.
	Prime Mover Coil	Insulation resistance			○		○	Be sure that insulation resistance is above 3 MΩ for low-voltage (above 10 MΩ for high-voltage). Use a megger.
	VS Coupling Coil	Insulation resistance			○		○	Be sure that insulation resistance is above 3 MΩ. Use a megger.
	Tachometer Generator	Insulation resistance			○		○	Be sure that insulation resistance is above 1 MΩ. Use a megger.
	Cable	Deterioration, damage		○			○	Replace if damaged.
	Grounding Wire	Slack, damage		○			○	Fasten with a wrench.
	Magnetic Starter	Load current	○			○		Check with an ammeter if load current is less than the rating.

Table 12 Inspection Schedule (Cont'd)

Component			Inspection Item	Schedule					Inspection or Maintenance Operation
				Daily	Monthly	Yearly	With motor running	With motor at rest	
External Inspection and Cleaning		VS Controller	Output shaft speed	○			○		Check if output shaft speed is within the rated speed range.
		VS Controller, VS Operator	External terminal			○		○	If loose, tighten with a wrench.
Internal Inspection and Cleaning	Prime Mover	Bearing	Damage			○		○	Replace.
		Frame	Dust, damage			○		○	Remove dust. Replace if damaged.
		Coil	Varnish deteriorated			○		○	Retreat coil.
		Rotor	Damage			○		○	Repair or replace.
		Bracket	Bearing fit, damage			○		○	Repair or replace.
		Fan	Dust, damage			○		○	Remove dust. Repair if damaged.
	VS Coupling	Bearing	Damage			○		○	Replace.
		Coil	Varnish deteriorated			○		○	Retreat coil.
		Frame	Dust, damage			○		○	Remove dust. Repair if damaged.
		Inductor	Crack, damage			○		○	Repair if damaged.
		Drum	Crack, damage			○		○	Repair or replace.
		Tachometer Generator	Damage			○		○	Replace.
		Bracket	Bearing fit, damage			○		○	Repair or replace.
		Output Shaft	Damage, bent			○		○	Repair or replace.

TROUBLESHOOTING GUIDE

Table 13 Troubleshooting Guide

Symptom	Possible Cause		What to Do
Vibration	Foundation not rigid.		Check for adjacent vibration source, settled foundation, crevice and rigidity of mount. Rebuild. Reinforce mount.
	Low rigidity of bed.		Reinforce bed or rebuild foundation.
	Anchor bolts loosely tightened.		Tighten nuts for anchor bolts. Rebuild foundation.
	VS motor loosely mounted		Tighten frame fastening bolts.
	VS motor feet uneven.		Add shims under foot pads to mount each foot tight.
	Loose screws of prime mover and VS coupling.		Tighten screws.
	Coupling or V-belt sheave.	Eccentricity.	Measure run-out tolerance and compare with that of shaft. If over 0.05 mm, correct.
		Weight unbalance.	Correct.
		Damage.	Repair or replace.
	Pin-type flexible coupling.	Worn or damaged coupling pin.	Repair or replace.
		Poor position accuracy of holes for coupling pin.	Check position of tram marks. Correct.
	Misalignment.		Correct by realignment of drive. See ALIGNMENT.
	Worn or damaged bearing.		Check for vibration of bearing. Detect noise with a listening rod. Replenish grease if regreasable type. Replace bearing.
	Vibration in driven unit.		Disconnect VS motor from driven unit. Correct.
Bearing noise	Insufficient lubricant. Shrill chatter due to metal-to-metal contact. Where ambient temp. is below 0°C, noise may occur right after starting.		Check with feeler or bearing checker. Replenish bearings, if regreasable type, with grease, or replace.
	Slip between raceway balls. High pitch chatter.		
	Flaking, a form of pitting resulting from fatigue. Rattling or chattering.		
	Cracked ball or ring. Rattling or chattering.		
	Indentation due to dirt and rust. Grinding.		

Table 13 Troubleshooting Guide (Cont'd)

Symptom	Possible Cause		What to Do
Bearing noise	Electric pitting caused by the passage of electric current across the surface of raceway. Buzz or low pitch buzz.		Check with feeler or bearing checker. Disassemble motor and inspect bearings. Check for axial current and vibration. Replenish bearing, if regreasable type, with grease, or replace.
	Outer race rotates. Grinding.		Check with feeler or bearing checker. Check bracket fit.
Magnetic noise	Noise due to electromagnetism including high frequency 100 Hz or above. With power switch OFF, magnetic noise disappears.		Motor generates magnetic noise in general. No trouble unless noise is extremely high.
Noise of VS motor	Intermittent noise due to accumulation of foreign matter between inductor and drum.		Disassemble VS coupling and check the gap. Remove foreign matter. Check atmospheric condition.
Coupling noise (Chattering)	Gear coupling	Insufficient lubricant.	Supply oil. Check for oil leakage and repair.
		Worn gear tooth.	Remove coupling and check tooth mesh. Replace coupling.
	Pin-type coupling	Worn or damaged bush.	Check bush.
		Poor accuracy of bush.	Replace.
	Output shaft speed low.		Read tachometer of VS operator. Operate VS motor within rated speed range.
	Overloaded.		Check primary current of prime mover. Operate VS motor below rated current.
	High ambient temperature.		Keep ambient temperature below 40°C at all times. Check ventilation conditions and air temperature at inlet. Remove obstacles.
Motor runs hot.	Deposits of dust.		Check for dust, ventilation and heat dissipation. Disassemble and clean motor.
	Bearing temperature excessively high (See Note.)	Too high belt tension.	Correct belt tension.
		Small bearing gap.	Replace bearing.
		Eccentricity at time of bearing assembly.	Remount bearing correctly.
		Burnout of bearing.	Replace bearing.
		Excessive thrust from driven unit.	Eliminate.
With VS motor coupled to driven unit, starting prime mover causes rotation of VS motor without excitation.	Foreign matter stuck between inductor and drum.		See if shafts of prime mover and VS motor rotate simultaneously turning VS motor output shaft by hand. Remove prime mover from VS coupling and clean.

Note) Temperature cannot be measured from outside. However, temperature of frame and bracket will rise if temperature of bearing becomes extremely high.

Table 13 Troubleshooting Guide (Cont'd)

Symptom	Possible Cause	What to Do
Energized VS motor rotates when speed setting potentiometer is set at zero.	Adjustment of bias potentiometer improper.	Check bias adjusting, referring to instructions for VS controller or regulator.
Energized VS motor does not rotate even if speed setting potentiometer is set to higher speed.	Power may be off in VS controller or VS operator.	Check wiring and repair.
	Excitation coil of VS coupling or output circuit of VS controller (regulator) or VS operator is shortcircuited or grounded.	See if protective fuse is blown. Refer to instructions for VS operator or VS controller (or regulator).
	Excitation coil of VS coupling or output circuit of VS controller (or regulator) or VS operator is disconnected.	Measure coil resistance with tester across terminals. Check wiring. Replace coil or correct wiring.
	Dust stuck between inductor and yoke.	Remove dust.
	Bearing of output shaft seized.	See if motor output shaft is locked. Replace bearing.
Speed of VS motor unadjustable	Defective wiring to tach-gen.	See if VS motor continues to rotate at maximum speed. Refer to instructions for VS controller or regulator.
	Incorrect wiring of output terminals for tach-gen.	
	Failure of tach-gen.	
	Failure of regulator.	
	No load or little load.	See if load is less than 10% or rating. Increase load to rating.
	Load driving VS motor.	Decrease load, referring to specifications.
Speed of VS motor unstable.	Periodic load fluctuations.	Check driven load. Mount flywheel or refer to instructions for VS controller or regulator.
	Poor bias adjusting.	Check bias adjusting, referring to instructions for VS controller or regulator.
	Leads between VS operator (regulator, or VS operator) and tach-gen poorly connected.	Check wiring and correct.
	Failure of regulator or VS controller.	Check static characteristics. Refer to instructions for VS controller or regulator.
VS motor does not come up to rated speed.	Overload.	Measure load and reduce to nameplate rating.
	Poor adjusting of voltage correcting potentiometer 3VR for tach-gen.	Check bias adjusting, referring to instructions for VS controller or regulator.
	Excitation coil of VS coupling or output of regulator (or VS controller) is shortcircuited or grounded.	Measure coil resistance with tester applied across terminals. Replace coil.
Sudden stop of motor while in operation.	Excitation coil of VS coupling or output circuit of regulator (or VS controller) is shortcircuited or grounded.	See if protective fuse is blown. Replace coil or correct wiring.

Note) Temperature cannot be measured from outside. However, temperature of frame and bracket will rise if temperature of bearing becomes extremely high.

RENEWAL PARTS

As insurance against costly downtime, it is strongly recommended that renewal parts be kept on hand in accordance with the table below.

When ordering renewal parts, specify to Yaskawa Electric office or representative with; Parts Code No. and Quantity.

Table 14 Renewal Parts

Rated Voltage	Nominal Output kW				VS Coupling Frame	Bearing				Inside Diameter of Tachometer Generator Shaft (Type TGS-3B-3)
	Constant Torque Characteristics		Variable Torque Characteristics			Prime mover End		VS Coupling End		
						Opposite Drive End		Drive End		
	4-pole	6-pole	4-pole	6-pole		Outside	Inside	Inside	Outside	
200 VAC, 400 VAC	45	-	45 55	-	37G	6312LLB (VV)	NU316CM	6314CM	NU314CM	70 mm
	55 75	45	75 90	45 55	42G	6312LLB (VV)	NU316CM	6315CM	NU316CM	85 mm
	90	55	110 132	75 90	46G	6316CM	NU318CM	6316CM	NU316CM	
	-	-	160 200	110 132	51G	6316CM	NU318CM	NU318CM	6316CM	
	-	-	-	160	56G	6318CM	NU320CM	NU320CM	6318CM	
3000 VAC	45 55	45	45 55	45	42G	6312LLB (VV)	NU316CM	6315CM	NU316CM	
	75	-	75	55	42G	6316CM	NU316CM	6315CM	NU316CM	
	90	55	90 110	75 90	46G	6316CM	NU318CM	6316CM	NU316CM	
	-	-	132 160	110 132	51G	6316CM	NU318CM	NU318CM	6316CM	
	-	-	200 250	160	56G	6318CM	NU320CM	NU320CM	6318CM	

A Better Tomorrow for Industry through Automation
YASKAWA Electric Mfg. Co., Ltd.

TOKYO OFFICE Ohtemachi Bldg., Chiyoda-ku, Tokyo, 100 Japan
Phone (03) 284-9111 Telex 222-2273 YASKWA J Fax (03) 284-9034
SEOUL OFFICE 17-7, 4Ka, Namdaemoon-Ro, Chung-Ku, Seoul, Korea
Phone (776) 7844
SINGAPORE OFFICE CPF Bldg., 79 Robinson Road No. 24-03, Singapore 0106
Phone 2217530 Telex (87) 24890 YASKAWA RS
YASKAWA ELECTRIC EUROPE GmbH: SUBSIDIARY
Monschauerstrasse 1, 4000 Düsseldorf 11, West Germany
Phone (0211) 501127 Telex (41) 8588673 YASD D Fax (0211) 507737
YASKAWA ELECTRIC AMERICA, INC.: SUBSIDIARY
Los Angeles Office 14811 Myford Road, Tustin, California 92680, U.S.A.
Phone (714) 731-6841 Telex (230) 678396 YASKAWAUS TSTN Fax (714) 730-8294
Chicago Office/*YASNAC* America 305 Era Drive, Northbrook, Illinois 60062, U.S.A.
Phone (312) 564-0770 Telex (230) 270197 YSKW YSNC NBRK Fax (312) 564-3276
YASKAWA CORPORATION OF AMERICA: SUBSIDIARY
14811 Myford Road, Tustin, California 92680, U.S.A.
Phone (714) 731-7911 Telex (230) 678396 YASKAWAUS TSTN Fax (714) 730-8294
YASKAWA ELÉTRICO DO BRASIL COMÉRCIO LTDA.: SUBSIDIARY
Av. Brig. Faria Lima, 1664-cj. 611, Pinheiros, São Paulo-SP, Brasil CEP-01452
Phone (011) 212-5464, 813-3694 Telex (011) 24168 FERN BR

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