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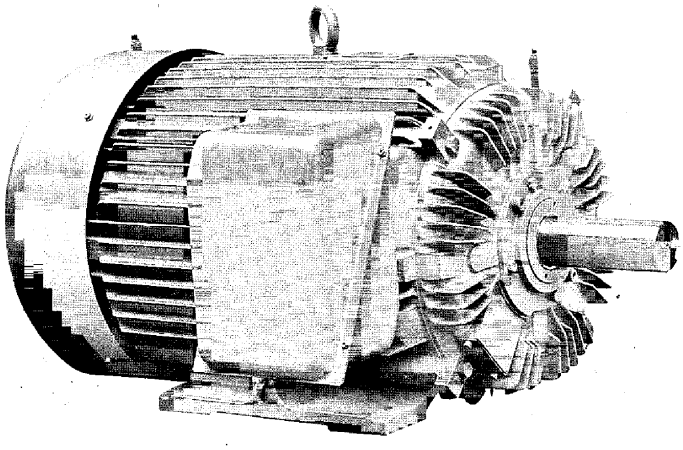
THREE PHASE INDUCTION MOTORS

MAINTENANCE MANUAL



1.Check on receipt

Please check the following items on receipt.

A. Read carefully the testing records.
B. Check and see whether the motors are damaged or dirtied; and make sure there is no part or accessory missing and no foreign body in the motors.
C. Run the motor and make sure the direction of rotation agrees with that indicated, if there is such an indication. The direction is always indicated by an arrow plate attached on the motor.
D. Read carefully the ratings on the main nameplate and other plates or attached pamphlets.
E. Rotate the shaft manually and make sure it rotates normally. (To prevent against axial movement of rotors and damages to roller bearings, the shafts of motors of 2 poles and motors with roller bearings are locked during transport. Please unlock them before rotating.)
F. If there are some special requirements, such as, certain particular color, paint, and accessories, please check to see whether they are satisfied.

In case there is any problem or discrepancy found, please contact Tatung Company or its service station nearest to you, and give us the following in-formation: The type, poles, output capacity, voltage and frequency shown on the nameplate; also the test number and manufacture number (they are either marked on nameplate or on the endface of shaft).

The one way of locking the rotor.

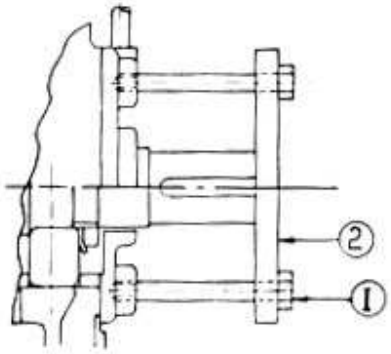


Figure 1.

Please unlock the bolts (1) and take away the shaft–end plate (2) before running the motor.

The other way of locking the rotor.

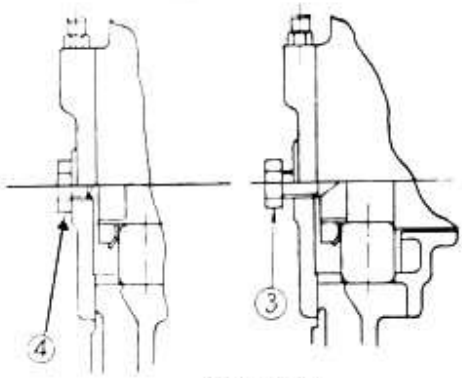
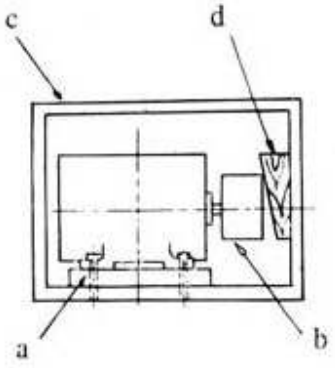


Figure 2

Replace bolt (3), shown in the drawing to the right, with bolt (4), shown in the drawing to the left, before running.

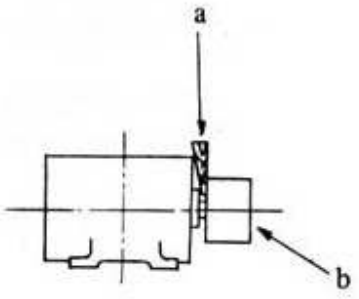
If you are a machine manufacturer, Please pay your attention to the following:

In case the rotors of Tatung motors you received have been locked for above-stated purpose, you are required to lock the rotors again, either by the means described above or by the means shown below:



a. The foot of the motor is locked to the bottom of wooden case.
b. Belt pulley or other transmission device.
c. Wooden case.
d. Wedge of hard wood or other proper material.

Figure 3



a. Wedge.
b. Belt pulley or other transmission device.

In case, you choose this way for locking the rotor, you must make sure that the belt pulley or other transmission device will not get loose during transport.

Figure 4

2.Installation

2.1 Installation environment

Since well selected environment contributes very much to proper functioning of motors, you, therefore , must give your careful consideration to this matter when you prepare your purchase specifications . However, to insure operational safety, the following items are listed for your information:

A. Environment temperature
   a. For standard motors, environment temperature normally has to be within the range from -15℃ to 40℃.
   b. In case the environment temperature is too high, or excessive heat is inflected on the motor, protective measures, such as cooling measures or heat-insulating measures, should be taken; or the load which makes the motor over-heated reduced.
   c. On the contrary, if the environment temperature is too low, heating measures will also be necessary.
   d. In case the motor is operated in the environment where the temperature falls out of the range as stated above, either too low or too high, design-wise re-consideration over the insulation, lead wire, lubrication, bearings fittings, steel parts and welding of the motor is deemed necessary.

B. Good ventilation
   a. If the circulation of cooling air into the motor is broken or impeded, abnormal temperature rising will occur.
   b. Please keep things at least 20cm off INTAKE AIR ports.

C. Poorly ventilated environment

   If the motor is installed in poorly ventilated environment, improvement steps have to be taken to guard the motor against being overheated.

D. If the motor is installed outdoor in moist or dripping environment, steps have to be taken to guard the motor against being overheated.

E. Dust

In a very dusty environment, following problems may rise; and periodical dusting is recommended.

a. Open type

A large accumulation of dust on windings and ducts of the core will result in over-heated windings. Moreover, dust and moisture retained by it may cause an insulation breakdown. In case dust accumulated around rotors is not evenly distributed, ill balance and, consequently, vibration may occur. If dust gets into the bearings, they may become damaged.

b. Totally - enclosed type

A large accumulation of dust on fins of frame, their heat-dispersing effect will be greatly reduced. In case the dust accumulated on fan or transmission device is not evenly distributed, ill balance and, consequently, vibration may occur.

F. Damaging gases and steam

In case damaging gases, such as corrosive gases, inflammable gases and other chemical gases, or steam exist in the environment, motors of explosion - proof type or anti-corrosion treated motors should be chosen; otherwise, protective or safety measures should be taken. Particular attention should be placed on motor selection, when inflammable gases or dust, or steam, which are all in CNS and standards of other countries to make sure the explosion-proof motors you selected are constructionally satisfactory.

G. Accessible site

Sites for installing motors should be accessible, i.e., in an open space so that motors will be carried to the sites and installed there conveniently. Moreover, the performance of jobs such as inspection, cleaning and maintenance (especially greasing) will not be handicapped.

H. Foundation invulnerable to vibration
    a. Motors should be installed on a solid and hard foundation or floor invulnerable to vibration from the environment.
    b. Severe vibration from the environment may inflict on motors installed there in the following damages:
        1. Depressions on roller bearings may occur during the periods when the motors are not running.
        2. Windings may break.
        3. The insulation of windings and their connecting wires may be damaged.

I. The ground or foundation on which motors are installed must be hard and stable; otherwise, the amplitude of vibration may become augmented continuously, especially when coupled with machines of high vibratility, such as crusher and reciprocating compressor.

    Vibration of large amplitude while the motor is running may bring about the following failures:

    a. The insulating on the windings may be damaged.
    b. The service life of bearings may become very short.
    c. Parts may get loose or become displaced.
    d. Cooling fan or other parts on rotor may fail due to fatigue.

J. Power supply
    a. The supplied voltage should be stable, and the voltage drop should be kept to the minimum under loaded condition.
    b. When the motor has to be powered by different voltage and frequency other than its rated ones, please refer to 4.2C and 5.2C for information. If it is not absolutely necessary, please do not do that , for motors may become over-heated and its performance may become undesirable.

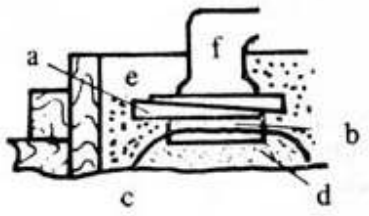
K. Altitude of installation site

    In case the sites are more than 1,000 meters above sea level, the temperature of the motors operated there will be 5 to 10℃ higher.

2.2 Foundation and installation

Foundation laying procedures will not be discussed here. As to installation of motors, your attention is invited to the following descriptions:

A. The base of motors should be buried into concrete or grout of the foundation to enable the motors to run stably. Do not bend or twist the base. Packers should be placed under the foot of motors (weight-bearing parts) and bearing stands. It is also necessary to place packers at both sides of base fastening bolts .All the packers should be spaced 300 to 500mm from each other so that they may share the weight on them evenly. It is better to use shrinkage-resist mortar and grout. The base fastening bolts could not be fastened until the mortar around them becomes completely hardened. Then considerable amount of grout should placed beneath the base so as to augment the stiffness of the foundation.



a. Taper pad.
b. Packer.
c. Concrete foundation.
d. Mortar.
e. Grout.
f. Base.

Figure 5.

B. Foundation and base for 2-pole motors

a. Since the synchronous speed of 2-pole motors reaches as high as 3,000 or 3,600rpm, if their foundation is not well designed and constructed, resonance may be resulted in. Be very careful, please.

b. Natural frequency and resonance

National frequencies of 2-pole motors are listed below:

	FIRST	SECOND
In 50Hz area	3,000cpm	6,000cpm
In 60Hz area	3,600cpm	7,200cpm

If the natural frequency of any other object in the installation equals or approximates any one of the values listed above, resonance will be resulted in.

If natural frequency (fn) is considered in one free degree, it may be expressed as:

$fn=1/2\pi \times \{(g\times K)/W\}\ ^\wedge\ (1/2)$

Where g=gravity acceleration

W=weight of coupling machine

K=elastic coefficient of the system

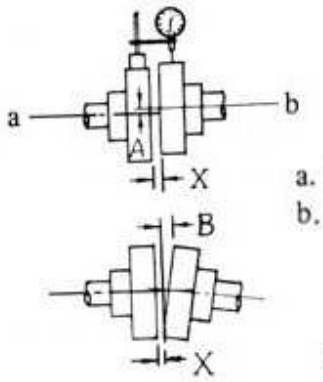
The values of W and K should be carefully chosen that the value of fn will not equal or approximate any values listed above. If resonance is noted or suspected when the motor is running, please measure the natural frequency and change it (see 7 for details).

C. Please check the following items upon completion of foundation and installation of motor base:
   a. Check and make sure that the foundation has the stiffness stated in 2.1H and 2.1I.
   b. Make sure the foundation possesses the stiffness required to keep the result vibration of the motor and its coupled machine to the minimum.
   c. Check and make sure the construction is strong enough that sinking or distortion of the ground and foundation will not happen.
   d. Check and make sure the concrete constructions have completed shrinkage or deformation.
   e. Make sure the foundation and base have been leveled. Coupled machines should be leveled to each other; the allowance of that should be kept under 0.2mm/IM.
   f. Make sure there are spaces for base bolts, cable wire, thermometers, space heaters and distribution pipes for conductors; and find out where they are.

3.Means of coupling

3.1 Centering

When the motor is directly coupled to driven machine particular attention should be paid to centering. First of all, check the bottom plane of the foot of motor with a level to make sure they are all at the same level. Secondly, fasten the foot to the base with bolts for trial installation. Thirdly, set the dial indicator on the lateral coupling device and rotate the shaft of motor gently to obtain precise dimension of A shown in figure 6. Fourthly, check the inclination between the shaft of motor and that of the coupled machine by inserting the thickness gauge into gap X shown in figures 6 and make adjustment, by inserting liners, when necessary to make every B around the disc of coupling device a minimum value possible.



a. Motor side.
b. Coupled machine side.

Figure 6

The allowance of A, B and X are listed below:

	Rigid Coupling Device	Flexible Coupling Device
A	0.03mm	0.05mm
B	0.03mm	0.04mm
X	0	The value designated by manufacturers

However, gear coupling or specially designed flexible coupling devices may have greater allowances than those listed above. Please contact the respective manufacturers for information.

3.2 Belt Transmission

Since V-belts are adopted as transmission means for motors of medium capacities, we take these belts as an example for our following discussion.

- The ratio of diameters of belt pulleys between motor and its coupled machine is 8 : 1 .

- The speed of V-belt must be kept under 22 to 23 m/sec. If the belt runs at a speed over 25m/sec., its slip and vibration will be increased and the belt itself will worn out much faster.

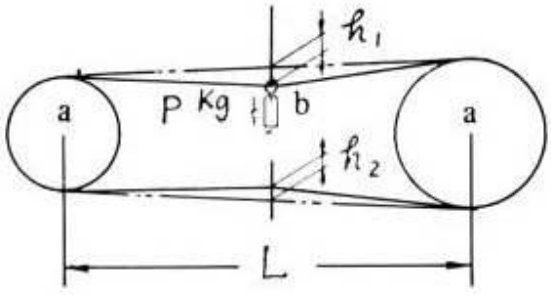
- In case the outer diameter of the pulley is too small, the bending force on the shaft will be increased in inverse ratio. If this force goes beyond the fatigue limit, a broken shaft is impending. in case a wide pulley of small diameter has to be adopted for belt transmission , please consult Tatung sales- engineers when motors are ordered.

- As to belt transmission, the following procedures will apply.

A. To insure uniform quality, it is ideal to obtain the belts, for one transmission device, from the same manufacture or the dimension allowance between the belts be kept within 0.2%. Please remember that when belts are selected. In case some of the belts on the same transmission device are damaged or worn out , please replace all the belts there on with new ones , not the damaged or worn ones only . Next, attention should be paid to pulley alignment, i.e. the shaft of motor should be kept parallel with that of its coupled machine; or the shafts be at right angle with belts or belt-pulleys.

B. Proper initial tension on the belts

If the tension is too large, a damaged, even a broken shaft may be resulted in . On the contrary, if the tension is too small. Slip of the belts will occur, desirable power transmission could not be achieved, and the belts and pulleys will become worn out more quickly.



a. Belt pulley.
b. Spring balance Figure 7

The initial tension of the belts can be found out easily by means described below: At the middle point between the shafts of the two belt pulleys, as shown in figure 7, a weight P is hung on the belt to obtain h1 and h2. The values h1 and h2 are the differences between the deflections before and after the weight is hung. The approximate values of.

e=2×L/(h1+h2) are shown in the following table .

Shape of V-belt	P (kg)	e	Transmission condition	
			Speed of belts	Output
C	5	35	16m/s	30Kw
D	10	35	25m/s	150Kw
E	10	45	25m/s	150Kw

You may adjust the adjusting bolts of the base to obtain the tension. The values of e are correlated with the speeds of belts and values of output, and adjustments of the values are necessary.

Another simpler way of measuring the tension is to measure the elongation of the belt; i.e. when the belt is elongated 0.5%, it is considered to have been mounted with proper initial tension. After the motor has run for ten hours, tension of the belt should be checked once again. After the motor has run for one month, the belt may become permanently elongated, and re-adjustment should be made then.

C. Replacement of V-belts

When the V-belt is deteriorated it must be replaced; otherwise, desired transmission cannot be obtained. Moreover, because of the diminution of friction coefficient, the deflection strength of the shafts will increase relatively. That will adversely affect the bearings. Generally speaking, when the permanent elongation of the belts reaches 1.5 - 2.5%, it should be replaced.

D. Special belts

Presently, nylon and steel wire belts are marketed in large quantities. In case these belts of high initial tension are to be adopted, high anti-flection strength for motor shafts will be required. Please inform Tatung when order is placed.

4.Running

4.1 Check before starting

Attention should be paid to the following descriptions before starting.

A. Distribution line

Please check, against the power distribution diagram, the power supply, magnetic switch and other protective device, Star-Delta Starter, reactor, compensator, lead wires for space heater and thermometers, and the distribution line of other driven machines.

B. Insulation Resistance

Make sure the wire connections are well fastened or welded, their insulation is in good condition, and the terminals are properly spaced from each other.

C. Grounding

Check and make sure the frame or terminal box of the motor is grounded.

D. Insulation Resistance

a. To test the stator and rotor windings by their terminal connectors.
b. Testing device of 500V be used to test stator windings below 3KV. Stator windings above 3KV be tested by 1000V device. All rotor windings by 500V device.
c. Insulation resistance varies with rates output and voltage, insulation classification and rpm of the motor. However, it also varies with the temperature, moisture, dust ridden condition, service period, testing voltage and testing period. Owing to the foregoing insulation resistance (R) cannot be measured. However, the following rule will apply.

3M ohm for rated voltage above 600V.

1M ohm for rated voltage below 600V.

or , formulae from JEC - 146 may apply;

R≧(rated voltage) /**rated output(KW)+1000**(M ohm)
R≧｛(rated voltage + rpm/3) / rated output (KW) +2000｝+ 0.5 (M ohm)

d. In case insulation resistance becomes low, the winding s must be dried by hot air, by vacuum, or by electrical current (short circuit, low voltage when unloaded, and DC current) as the situation dictates. In case resistance cannot be brought up to desired level after drying, some defects may exist. Please locate and repair the defects. In case, the job cannot be done, please contact Tatung Company or its service station nearest to you.

E. Lubrication

Motors are well greased during assembly. However, it may be a very long time from the completion of assembly in our plant to the beginning of running in your factory; it is necessary to make some replenishment. Tatung motors are greased with SHELL ALVANIA R3, when replenishment is made, please use the same or comparable products. For motors of special types, the specification and quantity of grease to be used are stipulated on respective nameplates.

F. Check and make sure the coupled machine is in good condition. Coupling condition, tension of the belts and fastening devices should also be checked.
G. Rotors of 2-pole motors or motors with roller bearings have often been locked during shipment, please make sure it can be rotated freely.
H. Check and make sure there is no foreign body left in or get into the motor or its coupling machine during assembly or shipment.

4.2 Starting

A. Starting load

As a general rule, motors are started without load for test running. Only after being proved normal it can be coupled with driven machine for further test. Motors are usually started with light load and switched to full load after full seed is reached, except otherwise required.

B. Direction of rotation-when viewing from non-drive end clockwise rotation is considered correct. After the terminal connectors U.V. and W (or 1,2 and 3) being connected to the connector R, S and T from power supply, the motor rotates counter-clockwisely , interchange any 2 of the 3 connecting leads. Most motors can rotate both ways. However 2- or 4-pole motors with high rpm or 6-pole motors with large capacities, their direction of rotation has to be limited to either clockwise or counter-clockwise. In this case, a plate bearing an arrow to show the direction of rotation will be attached to the motor.

C. Supplied voltage and current

a. Make sure supplied voltage agrees with or within ±10% of that shown on the nameplate. If the difference between rated voltage of the motor and supplied voltage, the windings may become overheated.
b. **Make sure the supplied 3-phase voltages are in balanced condition among phases.** A little bit difference among them, unbalanced currents of considerable values may be resulted in.
c. Make sure phase currents are balanced, otherwise windings will be exceedingly overheated and torque cannot be provided. Sometimes, abnormal noise and severe vibration may be accompanied.

D. Frequency

The maximum variation between rated and supplied frequencies should be within 5% under the rated voltage. If both voltage and frequency varies at the same time, the SUM of their absolute value should be within 10%.

E. Starting

In case the first starting is a failure, restarting can be made. However, as a principle, only two successive cold starting can be made at a time. If both efforts are failed, a 30 minutes interval should be allowed for primary and secondary conductors to get cold, which have been heated by starting current during these failed **starts.**

F. Starting time and noise

In case GD^2 of coupling machine is large, a longer starting time may required. However, if it is difficult to start or starting time is excessively long, and sever noise is noted during start, please contact Tatung or our nearby service activity.

G. Vibration

Determine the value of vibration with vibration meter or by feeling and compare that obtained with the data shown in Section 7 - Vibration. After this is completed, let the motor run alone. Then, run without load and then, run with full load. If nothing wrong during start, keep the motor running for 3 hours and take down the records every 15 minutes as stipulated below (5.2). In case nothing abnormal has been found, the motor will be kept on running and checks made every few hours. Still, there is nothing abnormal, the motor is considered serviceable and may be put into service.

5.Maintenance

5.1 Knock-down examination

For motors running continuously day and night, a knock-down examination should be made every 2 or 3 years. However, for motors designed for special purposes, knock-down examinations should be made in certain time periods prescribed respectively.

5.2 Records

A. Every day records

a. At what time (year, month, day and hour) and in what weather the test is conducted.
b. Voltage, load current, frequency (see 5.2C).
c. Ambient temperature (room temperature).
d. Temperature and noise around bearings.
e. Temperatures in stator windings and on frame surface (totally enclosed type). See 5.2C.
f. Abnormal vibrations and noise (see sections 7 and 8).

B. Records of periodical test and inspection

a. Insulation resistance and the relative humidity (see 4.1D).
b. Amplitude of vibration (see 5.2C and section 7).
c. The color and contents of grease discharged from bearings.
d. Dirt lodged in and on the motor.
e. Coupling allowance of coupling device; the tension of belts.
f. Fastening bolts for base . foot and other parts.
g. In case of oil lubrication , surface condition and clearness of the oil should be recorded. At the same time , check and make sure there is no leakage.

C. Some of the values obtained by above-listed tests and inspections are variable; their variable ranges given below:

a. The variation of voltage must be within ±10% of rated voltage. **The variation of frequency must be within ±5% of rated value when rated voltage is applied.** When voltage and frequency varies at the same time, the result of absolute values of the two variations must be within ±10%.

b. Temperature rise (maximum ambient temperature of 40℃) by TM and RM are listed below:

TM: THERMOMETER METHOD

RM: RESISTANCE METHOD

Part	Insulation	A Class		E Class		B Class		F Class		H Class	
	Type	TM	RM	TM	RM	TM	RM	TM	RM	TM	RM
Stator Windings	Types other than TEFC	50	60	65	75	70	80	85	100	105	125
	TEFC	55	60	70	75	75	80	90	100	110	125
Rotor Windings	Types other than TEFC	50	60	65	75	70	80	85	100	105	125
	TEFC	55	60	70	75	75	80	90	100	110	125

Bearing: 40℃ when test is made at the outer surfaces.
45℃ when test is made by inserted thermometer.
However , when hotresist grease is used for lubrication ,
the temperature rise can reach as high as 55℃.

c. Vibration (see Section 7 for detailed information)

Bearings: When their service life is compared with that of windings, the allowable values, when motors are running with load are listed below:

25 - 30 μ for 2-pole motors

50 - 60 μ for 4-pole motors

70 - 80 μ 6-and -more-pole motors

In case the vibration measured exceeds the above listed values, please check and find out the trouble, and corrective measures be adopted soonest.

5.3 In case periodical maintenance is necessary, it shoul**d** be done in accordance with the table attached at the end of this pamphlet.

6. Maintenance of Bearings

If not particularly prescribed, rolling bearings lubricated with grease are usually adopted for motors. Except close-type ball bearings, all other bearings are of open type so as to prevent from being over-greased by facilitating the injection and discharge of grease. Tips of maintenance are listed and explained below:

6.1 Tips for maintenance

A. Additional supply of grease should be given to the newly procured motors before they are started running, or to the motors have stopped running for more than 2 months before they are re-started for running.
B. After motors having started running, additional grease should be supplied at intervals and according to the quantities shown on nameplate.
C. The discharged grease should be removed timely.

6.2 Specifications, applications and constructions of ball and roller bearings.

The information is given in the following table, except that for specially designed motors:

Application		Non-drive end	Drive end
Foot-mounted and belt-coupled motors	Single shaft	Deep grooved ball bearing 63 □ □ CM	Roller bearing NU3 □ □ CM
Foot-mounted motors coupled by coupling devices		Deep grooved ball bearing 63 □ □ CM	Deep grooved ball bearing 6.3 □ □ CM
Vertical mounted motors coupled by coupling devices	Without or with light thrust	Deep grooved ball bearing 63 □ □ CM	Roller bearing NU3 □ □ CM
	Small thrust	Deep grooved ball bearing 73 □ □ □	Roller bearing NU3 □ □ CM
	Medium thrust	Multiple-row bevel ball bearing 73 □ □ □	Roller bearing NU3 □ □ CM

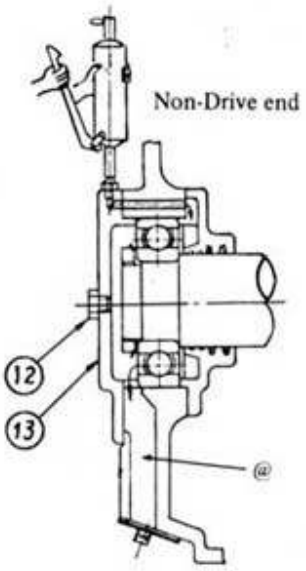


Figure 8
@ Storage for discharged grease

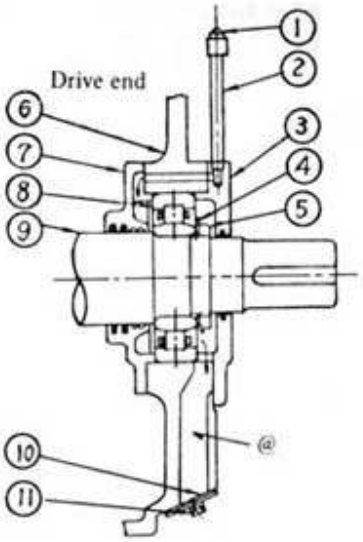


Figure9
@ Storage for discharged grease

1	Grease nipple	8	Rolling bearing
2	Grease injection pipe	9	Shaft
3	Outer bearing-cap	10	Grease exit cover
4	Lock washer	11	Cover set-screw
5	Lock nut	12	Bolt
6	Bearing bracket	13	Bearing housing
7	Inner bearing-cap		

6.3 After stopping running for a long period (more than 2 months):

A. Make sure checks described in item 1 and 4 have been completed.
B. After beginning running, grease should be injected at once. The quantity to be injected is shown on nameplate.
C. Temperature rise around bearings after beginning running.
D. Loudness and tone of bearing noise.
E. Noise and vibration of the motor.
F. Vibration of the bearing.

6.4 Grease supply

Grease supply is considered the most important thing in bearing maintenance. The primary purpose of grease supply:

- To keep the sliding surface lubricated.

- To maintain the grease film between rolling surfaces so as to facilitate load-carrying and resist wear. No noise will be heard if grease film is not broken and sliding surfaces properly lubricated.

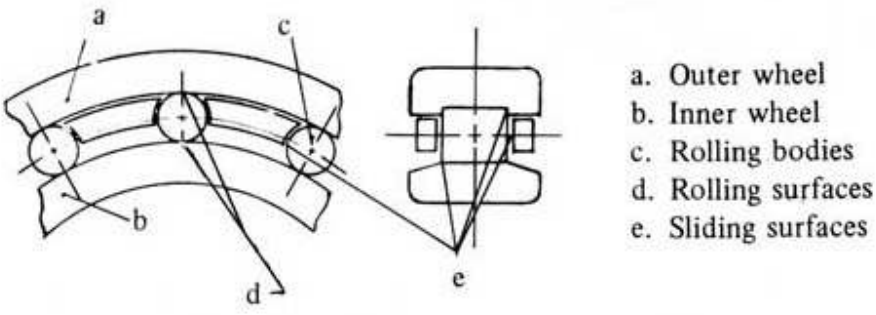


Figure 10 (Take roller bearing as an example.)

- To wash out the deteriorated grease and particles from worn part.

- The **existence** of grease will make the bearing corrosion proof, dust-proof and minimize the vibration and noise.

A. Make sure grease is supplied according the quantities and time intervals indicated on the nameplate.
B. For motors, which have stopped running for more than 2 months, a supply of grease should be given when they are started to run again.
C. When too much grease supplied, bearings will become overheated and maintain in this condition contin**u**ously; when too little grease supplied, grease may not be able to circulate to the inner part of bearings.
D. **I**nterval between grease supplies

If the motor runs 24 hours every day, the interval between supplies is indicated on nameplate. If the motor runs 12 hours one day and 8 or 3 hours the other day,

it will be considered as running 12 hours every day for deciding the interval of grease supply so as to insure good lubrication.

Table a Quantity and Interval of Grease Supply Ball bearing

Bearing No.	First filling (1)(g)	Consecutive supplies (2) (g)	Interval between grease supplies for Motors runs 24 hours everyday (in days) (3)					
			2-p	4-p	6-p	8-p	10-p	12-p
6310,6210	50	30	120	180	180	180	180	180
6311,6211	100	30	120	180	180	180	180	180
6312,6212	100	30	120	180	180	180	180	180
6313,6213	100	30	120	180	180	180	180	180
6314,6214	200	50	80	180	180	180	180	180
6215,6214	200	50	-	180	180	180	180	180
6316,6216	200	50	-	180	180	180	180	180
6317,6217	200	50	-	180	180	180	180	180
6318,6218	300	50	-	180	180	180	180	180
6320,6220	400	80	-	120	180	180	180	180
6322,6222	600	80	-	120	180	180	180	180
6324,6224	600	80	-	120	180	180	180	180
6326,6226	1000	100	-	-	180	180	180	180

Table B Roller bearing

Bearing No.		First filling (1) (g)	Consecutive supplies (2) (g)	Interval between grease supplies for Motors runs 24 hours everyday (in days)(3)				
				4-p	6-p	8-p	10-p	12-p
NU3 □□ NU2 □□ NU22□□	14	100	50	180	180	180	180	180
	15	100	50	180	180	180	180	180
	16	100	50	180	180	180	180	180
	17	200	50	120	180	180	180	180
	18	200	50	120	120	180	180	180
	20	300	80	120	120	180	180	180
	22	300	80	120	120	180	180	180
	24	400	80	-	120	180	180	180
	26	600	100	-	120	180	180	180

Remarks:

1. Quantity for first grease filling is the amount to be supplied after a knock-down clearing of bearings. 1/3 of which will be placed in the bearing, the rest in bearing covers.
2. Supply quantity is the amount of grease to be supplied each time after proper interval.
3. If the motor runs 8 hours one day and 12 or 6 hours the other day, the motor will be considered running 12 hours every day. The interval indicated in above tables may be doubled.
4. In case, the motor stated in c. is a 2-pole machine and 4- or 6-pole machine with roller bearings in large diameters (NU322 and above), the interval between grease supplies should not be doubled.
5. Please do not try to prolong the interval by increasing supplied quantity.
6. For 2-pole motors or 6-pole motors with roller bearings of large diameters, have started running after stopping running for more than 2 months, grease should be supplied according to interval and quantity indicated on the nameplate. Otherwise, noise may be heard and abnormal worn or damaged bearings may be resulted in.

6.5 Removal of grease

When the storage for grease discharged from bearing is filled, bearing may become over heated on account of viscidity resistance and grease leakage may occur. Therefore, please open the exit cover and let the grease out timely.

6.6 Problems of poor lubrication

	Properly Lubricated	Poorly lubricated
Sound	Only very weak sound could be heard from lace and retainer	Large noise from retainer or 2-pole motor's roller bearings.
Service life	The existence of oil film on various lubricated surface wear is greatly slowed down and long service life of bearings expected	Due to broken oil film, metal surfaces may contact each other. Excessive wear may occur and very short service life of bearings may be resulted in.
Heat	From viscidity resistance.	From the friction of direct contacting of metal surfaces.
Damage		Damage and noise caused by metal dust, Burnt retainer, Deformed or broken rolling bodied and outer and inner wheels.
Vibration		Gaps between worn retainer, rollers and balls will get larger; deformation and vibration may be resulted in.
Damaged bearings will give a burnt motor		When bearings are damaged, rotor will come down and be in contact with stator. Heat from their friction will burn the windings.

6.7 Bearing Diagnosis

If new grease is supplied and deteriorated grease discharged properly, the motor will run smoothly. When motors can not run well on account of trouble of bearings, tips for diagnosis are given below:

A. Noise from bearings.
B. Temperature rise of bearings.

Temperature rise is defined as the difference between the temperature of bearings and that of their surroundings. Its value is usually expressed as ℃. The allowable temperature rises are given in following table. However, when the temperature rise exceeds 40℃, please check and see whether there is anything wrong.

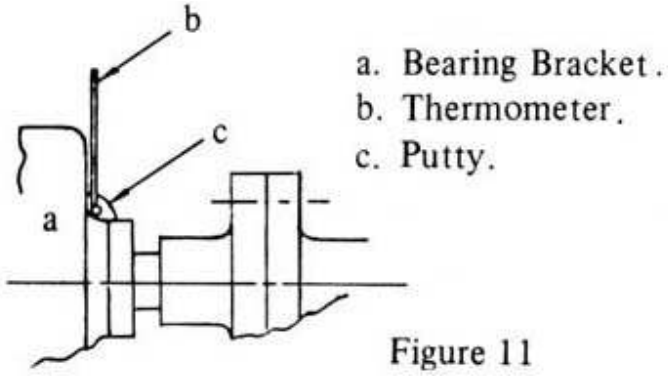


Figure 11

	Values of temperature rise (ambient temperature 40℃)	Readings from thermometers	Specifications	
Cap grease	40°	80°	CNS JIS JEC JEM	2934 C4202 37 1020
Heat-resist grease	55°	95°	CNS JEC JEM	2934 37 1020

When temperature rise varies during running, consider the following:

a. The viscidity resistance of newly supplied or discharged grease.
b. Insufficient grease or deteriorated grease.
c. Grease in bearing caps or on retainers falls into the bearing and viscidity resistance there increases abruptly.
d. The variation of load will cause the temperature of motor to go up.

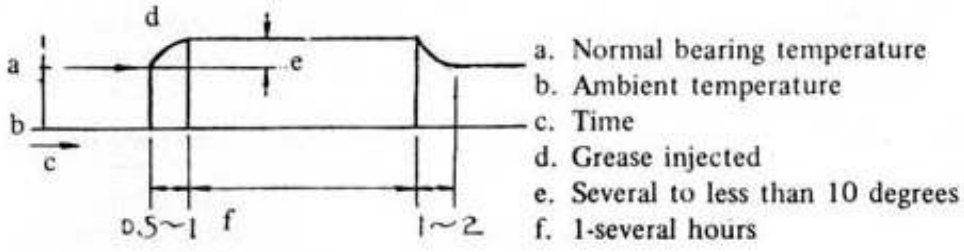


Figure 12

C. Variation of bearing vibration

As rolling surfaces and steel balls or rollers become worn, the gaps between them will become larger and the vibration will also become worse. Poor lubrication and insufficient compression force of locking washer, axial vibration may occur and whistling sound may be heard. In addition to deformation of and defects on balls, rollers and retainer, defects on rolling surfaces may also cause the vibration to become abnormally intensive. Therefore, it is very important to find out the causes of intensified vibration and take corrective measures.

D. General appearance of discharged grease

Color and odor	- White mixture may be considered as air and water mixed into the grease when churned by the bearings. - The grease in a new machine may become dark due to the grindings from rough surfaces. In this case, check and see whether the metal dust has got into the bearing. - In addition to chemical change, dust, air bulbs and water may mix into grease and make it deteriorate, discolor and smell bad.
Hardness	- Insufficient supply of fresh grease, old grease will remain in the grease groove. Fresh grease will get into the groove when sufficiently supplied.
Foreign bodies	- Matters other than grease may be wrongly injected; dust may get in.

6.8 Makers or brands of grease

All Tatung motors are greased with SHELL ALVANIA R3. Please adopt grease of the same brand or other qualitatively comparable products for grease supply.

Before you decide what maker or brand of grease will be chosen, please consider the following descriptions:

AVAILABILITY:	Choose the products of a worldwide supplier so that they will be always available.
TEMPERATURE:	Temperatures where in regular greases are serviceable range from -20°to 120℃. Beyond this range, greases for low or high temperature should be adopted.
For high rpm motors and motors with bearing of large diameters	Harder grease has better compression strength while softer ones may give minimum noise and vibration and allow an easy operation in injection and discharge. (Silicon grease prohibited.)
LOAD-BEARABILITY :	Grease of good compression strength for heavily loaded operation (belt or gear transmission). Silicon grease prohibited.
Moisture-proof :	Na-grease or Ca-grease is recommended for motor installed in moist environment.
Viscidity :	Among different brands of grease with same hardness, the one with lower viscidity is recommended to minimize noise, vibration and temperature rise of bearings after greasing and to provide good lubrication during cold weather and easy operation in grease injection and discharge.
Serviceability :	The better you understand lubrication products the wiser decision you will make in grease selection.

Mixture of different grease

Greases of same base (for example Li-base) and same category (for example mineral oil) but with different viscosities may be mixed together. In case grease to be supplied is different from that already in the bearings, and you have no other choice

but take it for replenishment, please inject a very large quantity of the supplied grease so as to replace all of that already in the bearing.

6.9 Tips for assembling and disassembling

Figure 13

<a> Disassembling tool

<b> Bearing

<c> shaft

<d> bolts

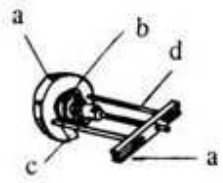


Figure 13

Figure 14

<a> Ball bearing

<b> Disassembling tool for ball bearings

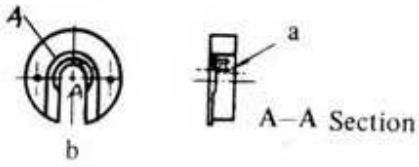


Figure 14

Figure 15

<a> Inner ring of roller bearing, NU type

<b> Disassembling tool for roller bearings

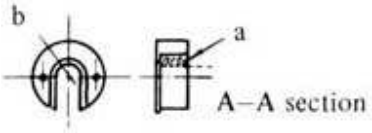


Figure 15

A. If the bearing disassembled from a shaft or other object is serviceable, please wash it with machine oil or coal oil Or it is wrapped well, without washing, to prevent moisture and dust from getting in. The disassembling be made in accordance with the procedures shown in the figures above. The pulling force be evenly distributed in the inner ring of the bearing.

Figure 16

B. The procedures below are for bearing assembling (contraction fitting)

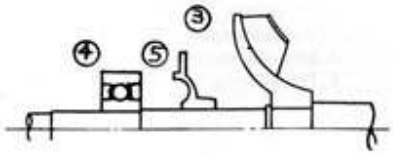


Figure 17

a. The bearing should be heated evenly; it can not be in direct contact with container. Please churn the oil sufficiently .
b. To prevent from deformation and being tempered , bearings are not allowed to be heated , even locally , over 120℃ . Put bearing in the oil and heat them gently to 100℃; then pick out the bearings for contraction fitting.
c. Vanes and inner bearing cap should be assembled first, if necessary.
d. The side marked with specification or model should face the viewer.
e. After contraction fitting, it should be pressed or hammered to make it in tight contact with the endface of bush. When pressed or hammered, the force must be directed to and evenly distributed on the inner ring as indicated in figure 19. Figure 18 shows the wrongful practice which is absolutely prohibited.

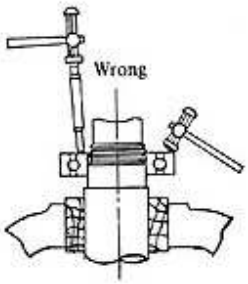


Figure 18

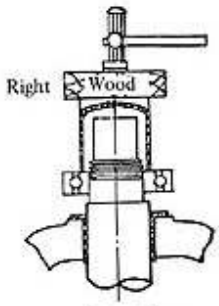


Figure 19

In addition to what stated above, you must also keep in mind the following procedures:

1. Make sure grease passages on bearing caps and brackets are aligned with each other.

2. The primary supply of grease should be filled into the bearing and its caps.
3. Sealing material should be applied into the joins of out-door type motors.

6.10 Sealed ball bearing

A. Construction

Sealed ball bearing has sealing plates on both sides while open-type bearing has not. Because of this difference in construction, the former has much longer interval between greasing.

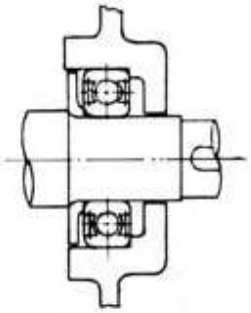


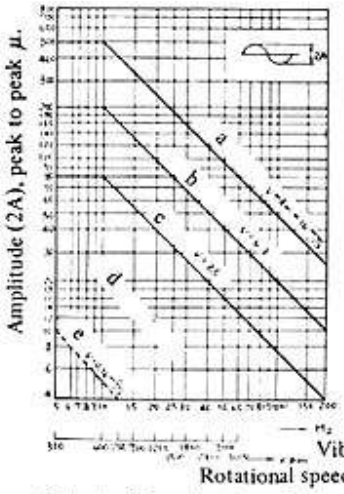
Figure 20

B. Knock-down examination

Knock-down examination should be conducted each 2 or 3 years. After the motor has been in service for about two years, the bearings should be checked with stethoscope rod for abnormal noise; and they may be replaced with new ones if the result obtained by the check so indicates. The sealing plates of sealed ball bearings may be dismantled for replacing grease. However, before the fresh grease is filled, the deteriorated grease should be thoroughly washed off with benzene or coal oil.

7. Vibration

Severe vibration may adversely affect the windings, bearings and coupling mechanism thereby causing them breakdown. When motor is running with load, the values of vibration must be no more than those listed in 5.2C. In addition, figure 21 also serves as a basis for deciding whether the motor is serviceable due to vibration. In case the values of vibration have gone beyond desired values, please try to find out where the trouble lies and see whether remedial measures may be adopted.



a. Breakdown
b. Needs to be repaired.
c. Normal.
d. Good or excellent.
e. Human sensible limit.

Criteria of the vibration of large machines fixed on rigid bases. Figure 21

(Remarks: In case the main vibration reaches values up to 2,000 rpm, even if the motor actually rotates at 1,000 rpm, the vibration should be considered as 2,000 rpm rotor.)

The list below is for your information:

a. Electrical Vibration

Vibrations	Description	Cause	Remedial measures
Vibrations caused by distortion of main magnetic flux	Vibration frequency=2f. Nothing to do with load. Proportional to V^2.	Natural vibration frequency of multiple-nod distorted stator approximates 2f.	Stabilize stator core. Check and see whether stiffness of foundation is sufficient.
Vibration caused by unbalanced main magnetic flux	Vibration frequency=2f or f/pxm (m=1.2); yielding a noise by 2sf. Stator shakes in certain directions. Severe vibration not proportional to voltage and having nothing to do with load.	Distorted rotor gives non-uniform air gap Perimeterwise-dis-tributed windings are not even Unbalanced rotor gives vibration of great magnitude . Natural vibration frequencies of foundation stand, stator and rotor approximates the frequency of power source .	Repair the rotor to obtain uniform air gaps Adjust windings to obtain balanced flux. Reduce bearing gaps. Install voltage balancing line. Test the stiffness of foundation.
Vibration caused by mutual action forces between currents of stator and rotor	Vibration frequency=2f. Large magnitude at starting or with load.	Unbalanced windings (broken wire or unbalanced resistance in secondary circuit .	Balance the windings.
Vibration caused by pulsating torque	Vibration frequency=2f. Vibrating force acting toward the perimeter of rotor.	Unbalanced voltage source. Unbalanced windings.	Adjust the voltage and windings.

b. Mechanical Vibration

Vibration caused by unbalanced weight	Vibration frequency= n.	Unbalanced residuum. Unevenly accumulated dust. Dried insulation. Eccentric deformation by heat. Worn vanes	Dynamic balancing. Cleaning and repairing. Replace worn vane and cutter.
Vibration caused by bent shaft	Vibration frequency = n.	Bending caused by external force. Deformation by heat.	Straighten or replace bent shaft.
Vibration caused by cylindrically deformed shaft	Vibration frequencies=2n,3n	Elliptic or triangular shaft section .	Repair deformed shaft.
Vibration caused by defective rolling bearings	Vibration frequency uncertain . If vibration is caused by defective rolling surface , frequency=number of balls in the bearing x N (nature number)	Depression caused by external vibration during transport or none running periods. Damaged by over load or worn out through normal use.	Replace the bearing.
Vibration caused by ill-installed rolling bearing	vibration = n,or uncertain. Larger axial vibration	Shaft not at right angle with rolling surface. Distorted	Repair the shaft. Knockdown for reassembling.

	magnitude.	bracket.	
Vibration caused by characteristics of bearings	Frequency uncertain . Larger axial vibration . Nothing to do with rpm .	Non-linear characteristics. Resonant brackets. Excessive gaps.	Pre-compression Reduce gaps Replace bearings Modify fittings, change grease.
Oil-whip	Frequency = n/2. Occurs when speed is 2 times of dangerous speed or above .	Self-excited vibration caused by oil film.	Grease of low viscosity. Reduce the width of bearings. Enlarge bearing gaps. Check the diameter at the neck of shaft.
Vibrations caused by distortion coupling devices of driven machine	Frequency = n. Vibration disappears when uncoupled.	Mal-alignment between shafts. Insufficient straightness of shaft.	Adjust the coupling Re-alignment of coupling device.
Vibration caused by improper installation (resonance with installation system)	Vibration frequency equals n, 2n; f, 2f.	Motor base and foundation are not properly coupled with driven machine. Resonance between vibration system of both sides.	Adjust the installation system . Change natural frequency of the system.

f: frequency s: slip p: pole pairs m: integer n: rpm

If the motor vibrates severely during running , cut off the power supply and see whether the vibration is mechanical or electrical . Next , vary the load when the motor is running or let it run without load for determining the cause of vibration .

Measure and alter the natural frequency.

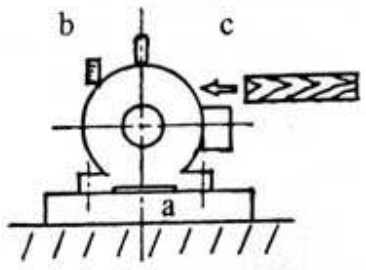
Measuring natural frequency by strike test.

A synchronous vibration meter be attached on one side of the upper part of motor . Then collide the motor at the other side of the meter , as illustrated in figure 22. The test should be conducted both axially and laterally. Natural frequencies obtained by this test should be within the ranges below :

In 50Hz Area : Below 2000cpm, 3600-4800cpm , and above 7400cpm.

In 60Hz Area : Below 3000cpm, 4400-6000cpm , and above 8000cpm.

If any natural frequency falls beyond the above ranges , an adjustment of base cotter may be considered , or additional grout be poured into or around the base to rise up the natural frequency . The reason why we recommend grout instead of concrete is that the latter shrinks.



a. Base
b. Synchronous Vibration Meter.
c. Strike with wooden slab.

Figure 22

8.Noise

8.1 Noise be measured based upon JEM 1020

a. Microphone be placed 1 meter from the motor at the same height of its shaft.
b. Make 4 measurements around the motor , and take the average of the obtained values as the noise level.
c. A-scale be adopted for noise compensation circuit.

8.2 Reflexion from the surrounding (room coefficient) and noise from the surrounding

Noise measuring should be conducted in the surrounding with minimum reflexion . In a concrete building , space of the room , facilities in the room and the relative positions of machines contribute a great deal to reflexion , which , in turn , influence the measured noise level . Therefore , below the range of 3dB(A), the measured noise level may become louder than actual level.

When the noise level of the motor equals that of the driven machine , their result is augmented by 3dB; when the difference between them is 6dB, the higher level is augmented by 11dB; when the difference is 10dB, the higher level dominates. Should corrective steps be taken , machine with higher noise level must be adjusted first.

Check points for routine maintenance

Part To Be Checked	Period Of Check	Itemes To Be Checked		Corrective Steps
Motor Frame	Annually	vibration	Vibration meter, Feeling	Find out the cause of abnormal vibration and corrective steps taken.
	Annually	Noise	Hearing, Stethoscopic rod	Make a survey of the site.
	Annually	Temperature of frame	Feeling or Thermometer	Check power source, load and dust accumulated on fins. Correction be made.
	Annually	Dirt on the frame		
	Annually	Ventilation	Temperature of circulating air, by feeling or thermometer	Check and see wheather the inlet and outlet of air are blocked. Clean the blinds, air nets and air filters.
Power Source	Annually	Voltage & current	Electrical measuring meters	Check and see wheather there is any change of the rated value.

Part To Be Checked	Period Of Check	Itemes To Be Checked	Corrective Steps	Part To Be Checked
Bearing	Annually	Sound from bearings	Stethoscopic rod	Grease be supplied and removed as prescribed on nameplate Surface layer and color of the oil. Look up 6.1, 6.2 and 6.3 for information .
	Annually	Temperature of bearings	Thermometer	
	Annually	Vibration of bearings	Feeling or Vibration meter	
	Timely	Discharged grease	Color, hardness and foreign bodies.	
	Annually	Oil leakage		
Inside The Motor	Every 6 Months	Mega ohm of windings	Megger	Periodic cleaning.
	Annually	Bad odor	Open type machine	
	Annually	Dirt	Dust, foreign bodies and water.	
Others	Annually	Coupling status	Coupling device , belts ougears.	Stop the motor for checking.
	Annually	Protctive device	Make sure they are in serviceable condition.	
	Annually	Fastening device	Foot-fastening bolts and other fasteners.	

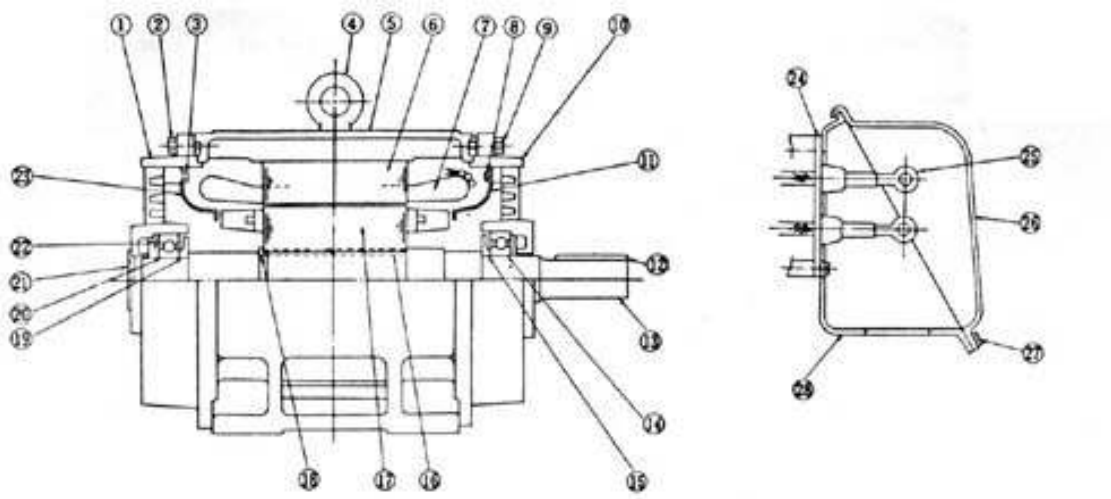


Figure 23

The structure of 3ϕ induction Motor. Squirrel Cage. Rotor , Enclosed-Ventilated type

1.Bearing bracket	8.Fastening bolts for air guiding plate	15.Shaft hole sealing device	22.Preload spring
2.Fastening bolt for bracket	9.Fastening bolts for bracket	16.Rotor fastening key	23.Air-guiding plate
3.Fastening bolts for air guiding plate	10.Bearing bracket	17.Rotor core, end-ring & vanes	24.Terminal plate
4.Eye bolt	11.Air guiding plate	18.C-clamp	25.Terminal cover
5.Frame	12.Key at shaft-end	19.Shaft hole sealing device	26.Terminal cover
6.Stator core	13.Shaft	20.Ball bearing, sealed type	27.Terminal fastening bolts
7.Stator winding	14.Ball bearing, sealed type	21.Duster	28.Terminal box

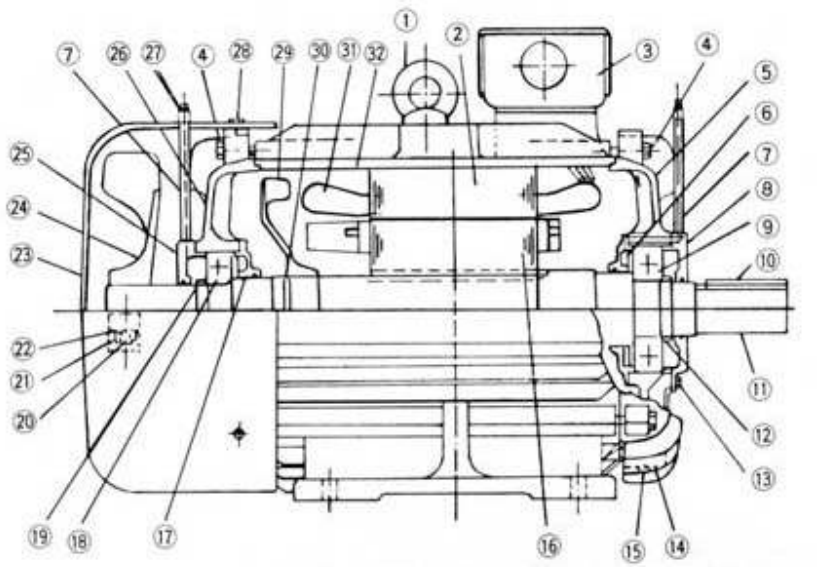


Figure 24

The structure of 3ϕ Induction Motor. Squirrel Cage Rotor Totally-Enclosed Fan-Cooled

1.Eye bolt	9.Bearing	17.Inner bearing-cap	25.Outer bearing bracket
2.Stator core	10.Key at shaft end	18.Bearing	26.Bracket
3.T-box	11.Shaft	19.Lock nut	27.Grease nipple
4.Fastening bolts for bracket	12.Lock nut	20.Fastener for fan	28.Fastener for fan hood
5.bracket	13.Fasteners for inner bearing cap	21.Hexagonal head bolts	29.Inner fan
6.Inner bearing cap	14.Grease outlet	22.Lock-washer	30.Fastening ring
7.Greasing Pipe	15.Fastener for outlet cover	23.Fan hood	31.Stator winding
8.Outer bearing cap	16.Rotor core. end ring	24.Outer bearing bracket	32.Frame