

TECH-TIPS

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The information contained within is intended to assist operating personnel by providing information on the general characteristics of the purchased equipment. It does not relieve the user of the responsibility of using accepted engineering practices in the installation, operation, and maintenance of this equipment.

Should a conflict arise between the general information in this manual and the contents of the drawings and supplementary material, the latter shall take precedence.

Safety Procedure

		DANGER
	<p>Dangerous voltages are present in the motor components which will cause serious injury, electrocution and equipment damage if safety precautions are not followed. To avoid serious injury and/or equipment damage – before any adjustments, servicing, wiring, parts replacement, or any other acts requiring physical contact with the electrical or mechanical working components of this equipment are performed – all equipment must be de-energized, disconnected and isolated to prevent accidental contact with live or rotating parts.</p>	
	<p>The successful and safe operation of motors is dependent upon proper handling, installation, operation and maintenance, as well as upon proper design and manufacture. Failure to follow certain fundamental installation and maintenance requirements may lead to personal injury and the failure and loss of the motor as well as damage to other property. This Instruction Manual must be thoroughly read before beginning any installation, operation or maintenance.</p>	
	<p>Only qualified personnel should be involved in the inspection, maintenance and repair procedure and all plant safety procedures must be observed.</p>	
	<p>A qualified person is one who is familiar with the installation, construction and operation of the equipment, and the hazards involved. In addition, he has the following qualifications:</p> <ul style="list-style-type: none">a. Is trained and authorized to energize, de-energize, clear, ground, and tag circuits and equipment in accordance with established safety practices.b. Is trained in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses, or face shields, flash clothing, etc., in accordance with established safety practices.c. Is trained in rendering first aid. <p>Motor should be installed and grounded per local and national codes.</p> <p>Do not operate this equipment in excess of the values given on nameplate or contrary to the instructions contained in this manual. Operating in excess of these conditions can cause stresses and strains beyond designing limitations. Failure to heed this warning may result in equipment damage and possible personal injury.</p>	

NOTE

Many squirrel cage induction machines are driven by various types of prime movers as induction generators. This instruction manual applies to both motors and induction generators. However, for clarity reasons, the machine will be referred to as a "motor".

Introduction

Warranty

See your sales contract for warranty coverage.

Receiving

Motors are shipped in first class condition. They have been inspected and are blocked or crated to prevent damage from ordinary handling during shipment.

Inspect new motors for shipping damage when received. Make the examination before removing from cars or trucks. If injury or indication of rough handling is evident, file a claim with the carrier at once, and notify your Joliet representative.

Remove only the shipping invoice. Do not remove tags pertaining to lubrication, operation and storage instructions. Read all tags and instructions to insure that no damage to motor bearings, (due to condensation) and motor windings occurs during storage.

Motors having grease lubricated anti-friction bearings are shipped with the bearings already lubricated and ready for operation. If available, energize space heaters to help prevent condensation within motor enclosure.

Motors having sleeve bearings or oil lubricated bearings are shipped WITHOUT OIL in the bearing reservoir. These bearings and journal surfaces are protected during shipment by a film of rust inhibiting oil.

Immediately upon receiving a sleeve bearing motor:

1. Remove shaft blocking materials.
2. Visually inspect bearing condition through sight glass and bearing drain opening.
3. Check for moisture accumulation. Remove any traces of oxidation before putting the motor in service.
4. Fill bearing reservoirs to normal level with a high grade industrial lubricating oil (See Maintenance).
5. Rotate the shaft a minimum of 10 complete turns by hand to distribute oil over bearing parts. Make sure the oil rings in each bearing rotate freely.
6. If available, energize space heaters to help prevent condensation within motor enclosure.

Handling

Lifting devices are provided for handling only. An experienced rigger should be used to install motors.

Lifting lugs near motor base or eye bolts are provided to facilitate handling with shackles and cables. Avoid pounding or bumping shaft, coupling or bearing parts, as shocks may damage bearings. To avoid damage, the use of spreader bars is recommended.

Note weight before lifting. The weight is indicated on the outline drawing. Lift only with base lifting lugs. Apply tension gradually to cables. Do not jerk or attempt to move the unit suddenly.



WARNING

Improper lifting can result in severe injury or death.
Do not attempt to lift with lugs on top cover.

Note any Warning plates on motor and follow instructions on each plate.

Motor Weight (In Pounds)

Factory Frame	Min. / Max.
500	2400 / 5300*
580	4000 / 6000*
680	6000 / 12000*

Generally, enclosed motor weights are at the upper range; open motors at the lower end.

Temporary Storage

If the equipment is not to be installed and operated soon after arrival, store it in a clean, dry, well-ventilated place, free from vibration and rapid or wide variations in temperature. Rotate the shaft a minimum of 10 complete revolutions each month to: coat the bearing with lubricant, retard oxidation or corrosion, and prevent possible false Brinelling.

Consider a unit in storage when:

1. It has been delivered to the job site; and is awaiting installation.
2. It has been installed; but operation is delayed pending completion of plant construction.
3. There are long (30 day) periods between operating cycles.
4. The plant (or department) is shut down.



NOTE

Storage requirements vary, depending on the length of storage and the climate. For storage periods of three months or longer – or climate variations consult factory.

Installation

Motor Dimensions

For motors built in these frame sizes, the letter dimensions have the same definitions as established NEMA standards. Established dimensions for these frames may be found on catalog sheets or certified drawings.

	<div data-bbox="824 407 1370 527">WARNING</div> <p data-bbox="824 537 1370 814">To avoid serious injury and/or equipment damage – before any adjustments, servicing, wiring, parts replacement or any other act requiring physical contact with the electrical or mechanical working components of this equipment is performed, all equipment must be de-energized, disconnected and isolated to prevent accidental contact with live or rotating parts.</p>
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Location

Select a location for the motor and driven unit that will:

1. Be clean, dry, well ventilated, properly drained, and provide accessibility for inspection, lubrications, and maintenance. Outdoor installations may require protection from the elements.
2. Provide adequate space for motor removal without shifting the driven unit.
3. Permit the motor to safely deliver adequate power. Temperature rise of a standard motor is based on operation at an altitude not higher than 3,300 feet above sea level.
4. Avoid condensation of moisture in bearings and on windings. Motors should not be stored or operated in areas subject to rapid temperature changes unless motors are energized or protected with space heaters.

Foundation

Concrete (reinforced as required) makes the best foundation, particularly for large motors and driven units. In sufficient mass it provides rigid support that minimizes deflection and vibration. It may be located on soil, structural steel, or building floors, provided the total weight (motor, drive unit, foundation) does not exceed the allowable bearing load of the support. Allowable bearing loads of structural steel and floors can be obtained from engineering handbooks; building codes of local communities give the allowable bearing loads for different types of soil.

For rough calculation the foundation should be approximately 2½ times total unit weight. Before pouring, locate foundation bolts by use of a template frame and provide secure anchorage (not rigid). It is recommended that a fabricated steel base be used between motor feet and foundation. See certified drawings of motor, base, and driven unit, for exact location of foundation bolts. Allow for grouting base when pouring. Case the base foot pads level and in the same plane.

Mounting

Mount the motor base (if used) on foundation or other support. Shim as required to level. Use laser or spirit level (check two directions at 90°) to insure motor feet will be in one plane (base not warped) when base bolts are tightened. Set motor on the base, install nuts and tighten. **DO NOT TIGHTEN UNTIL AFTER ALIGNMENT.**

NOTE

Experience has shown that any base mounted assemblies of motor and driven units temporarily aligned at the factory, no matter how rugged or deep in section, may twist during shipment. Therefore, alignment must be checked after mounting.

Coupling-Sleeve Bearing Motors

Sleeve bearings cannot withstand externally generated axial thrust. Therefore, the selection of coupling is of extreme importance. The following types of couplings are considered to be free from the development of axial thrust and may be used:

1. Laminated Metal Disk Type
2. Rubber Biscuit Type (Designed for the Speed)

Limited end float models of the following are available from several coupling manufacturers and may be used by selecting the proper end float.

3. Pin and Bushing Type
4. Spring Grid Type
5. Gear Type

External Wiring

NOTE

Before running motor, check "Initial Start Procedures" on page 6, Operation Section of this manual.

Starting and over-load control devices must be matched to motor rating. For safety or convenience they may need to be installed some distance from the motor. Follow the control manufacturer's instructions to make proper installations and connections. Observe the following:

1. Connect electrical power supply to conform with National Electric Code and any local regulations. Line voltage and wire capacity must match motor rating stamped on the nameplate.
2. With the driven equipment disconnected, momentarily energize the motor to check rotation.
3. If motor is three-phase type, reverse rotation (if required) by interchanging any two of the three power leads.



CAUTION

Motor may overheat if run in the wrong direction. Run in direction shown on motor, or change fans.

Changing Direction of Rotation

Look for rotation plates usually mounted on fan hous-ing or front housing of the motor.

Some external fans are directional type and should be replaced. The internal fans of all *two-pole* motors and many slower speed motors should be interchanged, end for end.

NOTE

It may be necessary to rebalance the rotor if the fans are changed.

Alignment

Accurate shaft alignment between machine and driven equipment is essential. Improper alignment may result in vibration, bearing overloads and excessive shaft stresses. Flexible couplings will not compensate for excessive misalignment.

NOTE

A basic rule is to not have more than 5 shims in a shim pack, under any one machine foot. Thick shim packs consisting of many thin shims will cause a soft foot and cause vibration or twisted frame (machine foot out of plane).

Parallel Alignment

After positioning unit for correct end float, separate the coupling halves and mount a dial indicator rigidly on one coupling half with the button on the cylindrical surface of the other half. Rotate the shafts together, and take readings at top, bottom and side positions. Align shaft so difference between top and bottom readings, and the side readings, is maximum of 0.002 inch for a flexible coupling or maximum of 0.001 inch for a rigid coupling.

Angular Alignment

Hold each shaft at maximum end float. Rotate both shafts together, and measure between matching points at the outside diameter of the coupling faces for the top, bottom and both sides. Use two indicators because of possible axial shaft movement. Read difference of variation between them.

Align shafts so that the total indicator variation does not exceed .002 inch (See Figure 1).

Completing Mechanical Installation

After controlling rotor end float and establishing accurate alignment, it is recommended to drill and ream the foundation plate and machine feet together for dowel pins. (See Doweling Instructions on page 5.)

Recheck parallel and angular alignment before bolting the coupling together. Motor shaft should be level within 1/32 inch after alignment.

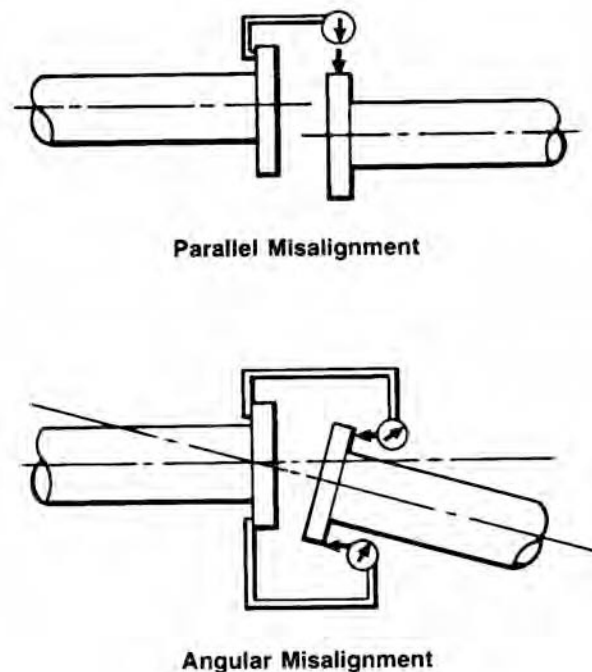


Figure 1. Diagrams Showing Parallel and Angular Misalignment

V-Belts

Check belt manufacturer's and motor manufacturer's recommendations for: Maximum speed of sheaves and belts, minimum pitch diameters, maximum allowable number of belts and maximum sheave width.

Use only matched-belt sets. V-grooves must be in line; sheaves must be parallel and axially aligned. Belts must enter and leave sheaves with no side bending. For long bearing life, the belt tension is important; consult belt manufacturer for proper tension to suit drive. Protect belts from grease and oil. NEVER use belt dressing.

Vibration

The standard housing vibration limits as measured under no load conditions (NEMA-MG1-20.52) are:

Speed, RPM	Amplitude, Inches
3000 and above	0.001
1500 – 2999, incl.	0.002
1000 – 1499, incl.	0.0025
999 and below	0.003

After alignment is complete and foot mounting bolts are tight, run motor at no load (for minimum possible). Check for vibration. If excessive vibration exists and the alignment is acceptable, check foot plane by loosening one drive end mounting bolt as detailed below.

Foot Plane

The proper foot plane is when adequate shims have been installed to assure equal pressure on each foot or corner of motor when the mounting bolts are loose.

To determine proper foot plane:

1. Mount dial indicator on shaft to be checked so contact will rest on either the adjacent shaft or a bracket from the foundation or base.
2. With mounting bolts tight and indicators set at ZERO, release one bolt at the drive end of the unit; check indicator for a change in reading (.001" maximum).
3. If no reading is indicated, retighten bolt and check the other drive end mounting bolts.
4. Add shims until retightening of bolt reduces or eliminates vibration.

Only one base bolt at drive end should allow indicator to read unless foot plane is very close and too many thin shims have been used causing a spongy condition to exist.

Base or foundation rigidity can also affect vibration; check for resonance in supporting structure.

RECHECK ALIGNMENT AFTER ANY CHANGE IN SHIMS.

Hot Alignment

It is possible for the motor shaft height to change relative to the driven equipment and should be compensated for during the alignment procedure.

Check for vertical alignment (parallelism) of coupled drive as follows:

1. Operate unit until normal temperature is reached (may require several hours).
2. Shut down motor and lock out switch.
3. Mount dial indicator as in Figure 2.
4. Rotate shafts, noting readings at 0° and 180° (top and bottom). If within 0.002 inch total indicator reading, or other limit specified by the factory, unit is satisfactory for operation.
5. If not within limits, add or remove shims as required to raise or lower motor.
6. If shims are changed for high temperature operation, repeat alignment procedure to extent necessary to assure proper alignment.

If motor application is abnormal (high temperature, extreme vibration, etc.), consult the factory for special instructions or additional information.

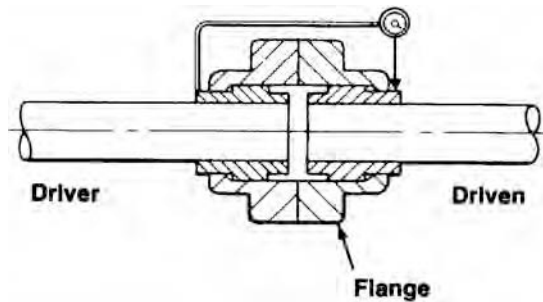


Figure 2. Check of Vertical Alignment

Doweling

Doweling the motor (and driven unit) accomplishes the following:

1. Restricts movement.
2. Eases realignment if motor is removed from base.
3. Temporarily restrains the motor, should mounting bolts loosen.

Inserting Dowel Pins:

The following procedures are recommended:

- a. Check the alignment after the unit has been in operation approximately one week. Correct if necessary.
- b. Through opposite motor feet, drill through and into the base, holes of a diameter 1/64 inch less than dowel pin. Clean out the chips.
- c. Ream the holes in the feet and base to the proper diameter for the pins (light push fit). Clean out the chips.
- d. Insert dowel pins.

Operation

Initial Start

After installation is completed, but before motor is put in regular service, make an initial start as follows:

1. Check that motor, starting and control device connections agree with wiring diagrams.
2. Check that voltage, phase, and frequency of line circuit (power supply) agree with motor nameplate.
3. If motor has been out of service or in storage (installed or uninstalled) see the following "Out of Service/Storage" before proceeding.
4. Check motor service record and tags accompanying motor. Be certain bearings have been properly lubricated and oil wells are filled. See MAINTENANCE.
5. If possible, remove external load (disconnect drive) and turn shaft by hand to assure free rotation. This may have been done during installation procedure; if so, and conditions have not changed since, this check may not be necessary.
6. If drive is disconnected, run motor at no load long enough to be certain that no unusual condition exists. Listen and monitor for excessive noise, vibration, clicking or pounding and that oil rings are turning if so equipped. If oil rings are not turning, stop motor immediately. Investigate the cause and correct before putting motor in service.
7. If drive cannot be disconnected, interrupt the starting cycle after motor has accelerated to low speed. Carefully observe for unusual conditions as motor coasts to a stop. Repeat several times if necessary.



CAUTION

Repeated starts can overheat the motor. Refer to NEMA MG-1-20.42 and MG-1-20.43 or consult factory.

8. When checks are satisfactory, operate at lowest load possible and look for any unusual condition. Increase load slowly to maximum, checking unit for satisfactory operation.

Out of Service / Storage

Cleaning

Both the interior and exterior of the motor should be free of spilled oil, water, dust and dirt. The exterior should be wiped and the interior blown out with compressed air at reduced pressure or with a small hand bellows.

Wipe off removable rust preventatives with a clean cloth soaked in petroleum solvent. Make sure that the bearings and lubricant cavities are free of dust and dirt, and that the (oil) plugs are tight. Scratches, bruises, or rust on the shaft journals must be carefully removed.

Relubricate Bearings (See Pages 14 – 16)

Remove Desiccant (If present.)

Test Insulation Resistance

Regardless of the method of storage, the windings of every motor should be tested prior to placing in service. Please refer to "Insulation Resistance" section under Corrective Maintenance later in this booklet.

Normal Operation

Start the motor in accordance with standard instructions for the starting equipment used. Sometimes the load should be reduced to the minimum, particularly for reduced voltage starting, and/or high inertia connected loads.

Voltage / Frequency Variation

Motors will operate successfully under the following conditions of voltage and frequency variation, but not necessarily in accordance with the standards established for operating under rated conditions:

1. If the variation in voltage does not exceed 10% above or below normal, with all phases balanced. Voltage unbalance should not exceed 1%.
2. If the variation in frequency does not exceed 5% above or below normal.
3. If the sum of the voltage and frequency variations does not exceed 10% above or below normal (provided the frequency variation does not exceed 5%).

Trouble Shooting

Between regular maintenance inspections, be alert for the following table. Correct any trouble immediately and signs of motor trouble. Common symptoms are listed in AVOID COSTLY REPAIR AND SHUT DOWN.

TROUBLE	POSSIBLE CAUSES	CORRECTION
Motor will not start.	Usually line trouble – single-phasing at starter. Load too heavy.	Check source of power supply. DON'T check with motor energized! Check overloads, controls and fuses. Check voltage, compare with nameplate rating. Disconnect motor from load to see if it starts without load. Reduce load – or replace motor with unit of greater capacity.
Excessive hum.	High voltage. Unbalanced rotor. Excessive wear of sleeve bearings.	Check input voltage and for proper connections. Balance. Replace bearings before introduction of scraping noise indicates rotor is rubbing against stator. Check alignment.

Regular clicking.	Foreign matter in air gap.	Take out rotor; remove matter.
Rapid knocking.	Bad bearing; dirt in lubricant.	Replace bearing; clean wells and renew lubricant.
Vibration.	<p>Misalignment in coupling or feet.</p> <p>Accumulation of dirt on fan.</p> <p>Vibration in driven machine.</p> <p>System natural frequency (resonance).</p>	<p>Realign set.</p> <p>Clean motor.</p> <p>Run motor disconnected for check. Eliminate source in machine, if possible.</p> <p>Alter rigidity of base structure.</p>
Vibration— <i>following motor repair.</i>	Rotor out of balance; balance weights or fan shifted on rotor.	Balance rotor.

<p>Motor overheating. (Check with thermo-couple or by resistance method – don't depend on hand).</p>	<p>Overload.</p> <p>Single phase.</p> <p>Dirt in motor or ventilating tubes.</p> <p>Unbalanced voltage.</p> <p>Rotor rubbing on stator.</p>	<p>Measure load; compare with nameplate rating; check for excessive friction in motor or complete drive. Reduce load, or replace motor with unit of greater capacity.</p> <p>Check current, all phases.</p> <p>Check flow of air. Check filters if so equipped. Blow out motor and ventilating tubes. Use solvent on wound section if necessary – use "ram rod" in tubes of tube-type motors. WARNING – To avoid personal injury, always use safety glasses when using compressed air.</p> <p>Check voltage, all phases.</p> <p>Clean air gap – check alignment. Replace bearings, if necessary.</p>
<p>Motor overheating (continued..)</p>	<p>Open stator windings.</p> <p>Over voltage / under voltage.</p> <p>Ground.</p> <p>Improper connections.</p>	<p>Disconnect motor from load. Check idle amps for balance in all three phases. Check stator resistance in all three phases for balance.</p> <p>Check voltage and compare to rating plate.</p> <p>Locate with test lamp or megger and repair.</p> <p>Recheck connections.</p>
<p>Fine dust under coupling having rubber buffers or pins.</p>	<p>Misalignment.</p>	<p>Realign unit.</p> <p>Inspect coupling.</p>

Bearing over-heating.	<p>Misalignment.</p> <p>Excessive tension in belt drive.</p> <p>Excessive end thrust.</p> <p>Too much grease (ball or roller bearing).</p> <p>Sticking oil ring (sleeve bearing). Oil ring out of round.</p> <p>Oil level too high or low (sleeve bearing).</p> <p>Insufficient lubricant.</p>	<p>Realign unit.</p> <p>Reduce tension to point of adequacy.</p> <p>Reduce thrust from drive or machine. Recheck mounting and alignment.</p> <p>Relieve supply to point set by manufacturer.</p> <p>Clean, repair, or replace. Recheck mounting.</p> <p>Correct oil level.</p> <p>Add to bring to proper level.</p>
Oil leakage or excessive oil usage.	<p>Excessive pressure or vacuum in bearing cavity.</p> <ol style="list-style-type: none"> 1. Heat exchanger tubes blocked. 2. Clogged oil return holes in bearings. 3. Bearing clearance too large. 4. Parts not sealed properly. 5. Loose heat exchanger tubes. 	<p>Clean tubes.</p> <p>Dismantle and clean bearings.</p> <p>Replace bearings, check alignment.</p> <p>Seal parts: -Drains; condensate and/or breather vent. -Conduit boxes (auxiliary and motor leads). -Partings; joints and oil guards.</p> <p>Roll tubes expanding tube inside diameters using proper expansion tool.</p>

Maintenance



General

Motors are designed to give many years of reliable service with a minimum of attention. But trouble-free operation cannot be expected if proper maintenance is postponed or neglected.

A definite schedule of preventative maintenance inspections should be established to avoid breakdown, serious damage and extensive downtime. The schedule will depend on operating conditions and experience with similar equipment. To assure adequate maintenance, it is essential that a complete record be kept for each machine, including description and rating, maintenance schedule and repairs required or carried out.

A systematic maintenance program required periodic inspection of the following to assure:

1. Motor clean; stator and rotor ventilation passages unobstructed.
2. Load not in excess of the rating or service factor.
3. Winding temperature rise not in excess of rated value.
4. Insulation resistance above recommended minimum.

	 DANGER
	High voltages used during insulation testing will cause injury or death. Testing by qualified personnel only. Refer to test device instructions for safety instructions.

5. Maximum voltage variation from rating, 10%; maximum frequency variations not to exceed 10%. Voltage unbalance between phases should not exceed 1%.
6. Check air gap. Record for future comparisons.
7. Bearing temperature is less than 90°C. Lubricant clean and proper level maintained.
8. No unusual vibration or noise.
9. Stock of essential parts.
10. List of spare units in storage.
11. Alignment data (departures from perfect alignment, allowance for high temperature).
12. Results of regular inspection (Service Record).
13. Repairs (Service Record).
14. Lubrication data:
 - a. Method of application.
 - b. Types of grease for wet, dry, hot, or adverse location.
 - c. Stock of greases and oils.
 - d. Maintenance cycle by locations (some require more frequent lubrication).
 - e. Record for each unit (Service Record).

Preventive Maintenance

Several of the more important items of good maintenance are discussed in the following pages. Others should be added when adverse or unusual conditions exist.



WARNING

Modification of explosion-proof or dust ignition-proof motors can cause explosions or fire.

Follow safety instructions below.



SAFETY INSTRUCTIONS

These motors are constructed to comply with the UL Label Service Procedure Manual. When reassembling a motor that has the UL Label, it is imperative that:

1. The original fits and tolerances be maintained.
2. All plugs and hardware be securely fastened.
3. Any part replacements are accurate duplicates of the original.
4. Reassembled motor must be inspected under UL Follow-Up Service Program; repaired motor is to be relabeled by UL-listed service shop.

To violate any of the above will invalidate the significance of this label, as the motor may no longer meet safety requirements for use in hazardous locations.

Inspection

Each machine should be inspected at regular intervals. The frequency and thoroughness will depend on the operating house, nature of service, and the environment.

Sleeve Bearing

Access to the motor interior can be gained by removal of the upper half of the horizontally split end shield.

1. Remove the upper bolts at the inner and outer circumference.
2. Pull the end shield away from the face of the frame and remove shield.

NOTE

Some motor air deflectors are fastened to the bearing housings. In others the air deflector is mounted to the motor frame.

The entire procedure can be done without disturbing the bearing enclosure or coupling alignment of the motor to the load. The split bearing capsule is held together by bolts.

Cleanliness

The interior should be kept free of oil, dust, dirt, water, and chemicals. It is particularly important to keep the air intake and exhaust openings free of obstructions.

NOTE

If equipment is operated intermittently in very damp locations, it should be protected by space heaters. To retard corrosion, grease all machined fits when the unit is reassembled after a maintenance check.

Loading

Overloading causes overheating and reduces insulation life. A winding subjected to a 10°C temperature rise above the maximum limit for its class may have its insulation life halved.

While somewhat less serious, underloading a motor is improper; it does lower the power factor, which results in higher power cost than would a smaller rated motor.

Temperature

Electrical apparatus operating under normal conditions becomes quite warm. Although some places may feel hot to the touch, the unit may be within limits. Use a thermocouple to measure winding temperature.

The total temperature, not the temperature rise, is the measure of safe operation. Investigate the operating conditions if the total temperature measured by the temperature detector placed on the winding exceeds:

- *230°F (110°C) for Class "B" Insulation
- *275°F (135°C) for Class "F" Insulation
- *302°F (150°C) for Class "H" Insulation

If checking total temperature by winding resistance or imbedded detector, total temperature should not exceed the following as they represent maximum insulation temperatures*. If operation occurs above these temperatures insulation life is shortened.

- 266°F (130°C) for Class "B" Insulation
- 312°F (155°C) for Class "F" Insulation
- 356°F (180°C) for Class "H" Insulation

Low Insulation Resistance

See CORRECTIVE MAINTENANCE

Vibration

Most problems can be detected when inspected visually. Check for:

Loose or missing parts, such as – fan blades, nuts, bolts, screws, couplings, etc.

Accumulation of dirt on fan or rotor.

Foundation construction – Base, grouting and associated equipment supporting drives. Vibration can be amplified by weak construction.

Associated equipment – Disconnect equipment to determine where the vibration is being generated.

History – When was vibration first noted: Was there a change in loading and/or duty of equipment? Has ambient vibration changed?

Often, more important than the actual vibration itself, is the change of *vibration* over a period of time. Velocity measurements are more indicative of vibration severity than displacement amplitude.

Corrective Maintenance

Two factors that require corrective maintenance are electrical failure or mechanical failure. The first sign of electrical failure is usually low insulation resistance. Mechanical failures are usually preceded by excessive bearing noise or heat.

Low Insulation Resistance

Factors that usually cause low insulation readings are:

1. Dirty windings (oil, dust, grease, salt, etc.).
2. Excessive moisture.
3. Mechanically damaged insulation.
4. Heat deterioration.

Dirty windings can be cleaned and moisture laden windings dried; however, items 3 and 4 require extensive repairs by a certified service center.

Cleaning

Clean the motor, inside and outside, regularly. Actual conditions existing around the motor dictate the frequency of cleaning operations. Use the following procedures as they apply.

Wipe off dust, dirt, oil, water, etc., from external surfaces of the machine. These materials can work into or be carried into the windings and may cause overheating or insulation breakdown.

Remove dirt, dust, other debris from ventilating air inlets and exhausts. Do not operate motor with air passages blocked or restricted.

Clean open motors internally by blowing with clean, dry compressed air at 10 to 60 psi. If the conditions warranty, use a vacuum cleaner.



WARNING

Compressed air can cause serious personal injury. Always use proper safety equipment.

Rotor Cleaning

Remove rotor. Inspect air vents and remove any obstructions that decrease ventilation.

Stator Cleaning

Form wound VPI insulated coils may be cleaned with a quick drying solvent and lint free cloths or steam cleaned with low pressure steam, then the entire stator oven baked at 200°F for 6 hours.

After any cleaning operation stator windings should be checked for insulation resistance.

The use of water and detergents for cleaning motor winding is not recommended on motors not having VPI insulation systems. The windings should be cleaned with a solvent, compatible with the insulation system and oven dried.

Insulation Resistance

Check insulation resistance periodically.

A hand cranked insulation resistance tester, not over 500 volts, is the most convenient and safest device to use.

Semi-conductors, small transformers, voltage regulators and other devices that may be damaged by high voltage, must not be in the circuit.

The standard of the Institute of Electrical and Electronic Engineers (IEEE) No. 43 is an excellent reference for the testing of insulation resistance. Very briefly, the publication recommends that stator winding insulation resistance (at 40°C), measured with 500 volts DC after one minute, should not be less than:

$$\frac{\text{Rated voltage} + 1000}{1000} = \text{Resistance in Megohms}$$

This formula is satisfactory for most checks.

Drying Insulation

If the megger reading is less than satisfactory, and the cause is excessive moisture in the windings; dry the windings by applying heat from:

1. A warm air oven.
2. Electric strip heaters.
3. Circulating currents through the coils.

The heat should be applied slowly so the desired temperature will not be obtained in less than six hours.

Insulating Drying Temperatures*

Class "B"	Class "F"	Class "H"
200°F 94°C	245°F* 118°C	275°F* 135°C

*Class "F" and "H" insulated units should be baked at 70% specified temperature (to avoid steam inside winding) for about six hours, before temperature is raised to drying temperature.

Insulation resistance should be measured before the heat is applied, and every six to eight hours thereafter

NOTE

Insulation resistance will decrease as the machine warms up; but will begin to increase shortly as the dryout continues.

A uniform temperature must be maintained in the machine to obtain constant resistance readings. When the megger readings remain constant, the drying out process is complete and may be discontinued. Check for other causes if readings are still low.

Warm Air Oven Drying

1. Remove bearing housings.
2. Remove rotor.

Bake in oven at temperatures per above table, and follow procedures described for drying insulation.

Strip Heater Drying

1. Remove bearing housings.
2. Remove rotor.
3. Direct a fan on stator to carry away the moisture.
4. Attach temperature indicators to winding and apply heat as specified in table. Follow procedures described for drying insulation.
5. Radiant type heaters are not recommended because some parts may become scorched before remote parts reach desired temperature.



CAUTION

High temperatures can damage insulation. Control temperature. Avoid hot spots.

Circulating Current Drying

1. Remove bearing housings.
2. Center the rotor in the stator core.
3. Wedge fiber strips into the lower part of the air gap, so rotor does not touch stator core.
4. Direct fan on unit to blow away excessive moisture.
5. Attach temperature indicators to windings and follow the procedures described for drying insulation. Do not exceed the drying temperatures in the table.
6. An external source of current can be used to circulate direct current through the windings of any type of A.C. machine. A portable low voltage motor-generator set, such as is used for welding, is usually suitable.

When this method is used on the stator, the stator phases may be connected in series or in parallel to suit the available power supply if both ends of all phases are accessible. If only three leads are brought out of the machine, the current may be circulated between one terminal and the other two connected together. If this is done, the temperature of the single lead connection must be checked frequently, and it is desirable to shift the leads occasionally. Usually 50 to 100% of full load current will produce the required temperature. The D.C. voltage required for this current will be 0.25 – 5.0% of the normal voltage per phase, and the corresponding power will be 0.50 – 3.25% of the rating.



CAUTION

High temperatures can damage insulation.
Remove rotor before applying A.C. current for drying.

Alternating current can be used on the stators of squirrel cage induction machines if the rotors are removed. Alternating current is usually not as easy to use as direct current. It is often more difficult to obtain the required voltage control, and ac requires a higher voltage source, approximately 10 to 30% of the rated winding voltage. In addition, care must be taken that miscellaneous parts adjacent to the winding, such as rotor bands, lead studs, core supporting members, etc., do not overheat due to induced currents and the lack of normal ventilation.

NOTE

Insulation resistance will decrease as the machine warms up; but will begin to increase as the drying process continues.

For more detailed information about insulation maintenance, consult factory.

Bearings

Long life of bearings is assured by maintaining proper alignment, belt tension, and lubrication at all times. Incorrect alignment of solid and flexible couplings can cause excessive load on bearings, and excessive vibration and thrust. Misalignment of belt drives can cause thrust or harmful shaft oscillation. Improper alignment of gear drives will produce shock loads and probably bend the shaft.

Bearing Construction

Two types of bearings are employed in large squirrel cage induction motors. These are:

1. Anti-friction bearings.
2. Split sleeve bearings.

The type of bearing mounting and enclosure will depend upon the type of bearing and the motor frame.

End frame construction will also vary with the type of bearing. Anti-friction bearing motors have one piece end shield construction. Split sleeve bearing motors have split end shields.

Sleeve Bearing Cavities

Oil Guards

The primary purposes of the oil guards are:

1. To prevent the entrance of dirt into the bearing cavity.
2. To retain the oil in the bearing cavity.
3. To provide pressure regulation from outside to inside the bearing cavity.

Bearing Clearance Too Large

Too large a bearing clearance or clogged oil return holes in the bearing will permit excessive oil to seep out the ends of the bearing. This seepage, combined with the rotation of the shaft, will create an oil mist inside the bearing cavity which will tend to leak through the oil guards. Excessive pressure in a forced feed lubrication system can also cause an oil mist to build up.

Cavity Pressures

Many motors are sensitive to the amount of pressure or suction existing in the bearing cavity. The maximum allowable is plus (+) or minus (-) 1/8" H₂O Pressure. This is measured with a water manometer at the oil fill pipe. For a correction of a high or low reading it is important that:

1. All tubes are sealed properly on tube cooled machines.
2. The partings and joints around the bearing cavity and oil guards are sealed.
3. The terminal box is properly sealed on tube-type motors.
4. Condensation drains piping, sight gauges and breathers are functioning properly.

Auxiliary equipment extending into the motor must be sealed to prevent a transfer of air from inside to outside the motor.

Sealing Parts

Apply sealant (Silicone RTV or Permatex #2; Permatex #2 only on explosion-proof and dust-ignition-proof motors) to the mating surfaces of parts, where oil is present, to prevent the seepage of oil. Even though joints seem to match perfectly, there are always minute clearances through which oil may leak.

Apply sealant as follows:

1. Surfaces shall be clean of dirt, grease, and oil sealant. Use a non oil base solvent if necessary.
2. The mating surfaces should be flat with no nicks raised above the surface. There should be no gap when mating surfaces are together.
3. Apply a thin coat to both surfaces (about the thickness of a business card). Do not apply too much as excess will be squeezed out and get into labyrinth seals, oil cavities, etc.
4. Assemble parts.

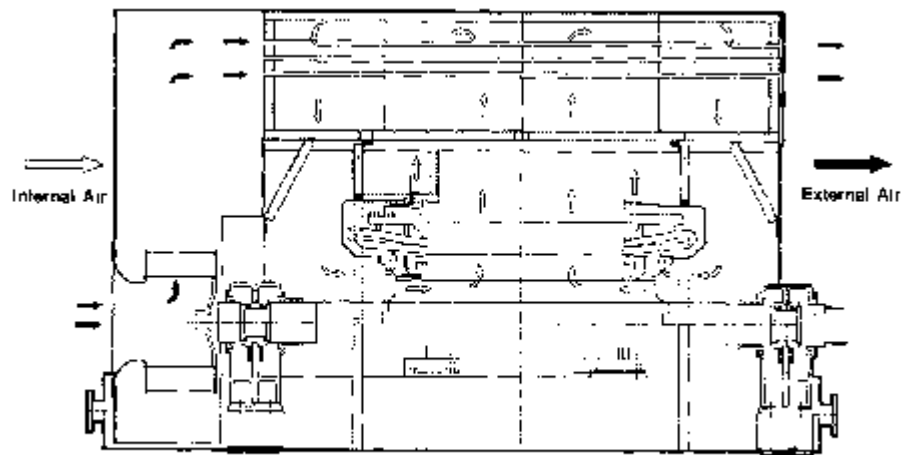


Figure 3. Tube Type Motor Cooling Diagram

Bearing Relubrication

The frequency of relubricating bearings and the amount added each time, depends on two factors – speed and service. As a guide the following is recommended.

Direct	Motor Speed	Relubrication
	3,600	6 months or
Belted	1800	12 Months or
	1800	3 Months or
	1200	3 Months or
	900	3 Months or

*Whichever comes first. Operating environment or application may dictate more frequent lubrication.

NOTE

A common mistake is over-lubrication of bearings. When grease is added without removing the drain plug, the excess grease must go somewhere and usually it is forced into and through the inner bearing cap and is then thrown into the windings. Proper lubrication is desired, but some under-lubrication is less dangerous than over-lubrication.

Grease

For best results, grease should be compounded from a lithium soap base and a good grade of petroleum oil. It should be of No. 2 consistency for roller bearings, No. 2 or 3 for ball bearings, and stabilized against oxidation. Mixing greases of different bases can soften greases, resulting in poor lubrication.

Operating temperature range should be from -15°F to $+250^{\circ}\text{F}$ for Class B insulation, and to 300°F for Class F and H. Most leading oil companies have special bearing greases that are satisfactory. For specific recommendations, consult factory.

Relubricate horizontal shaft motors as follows:

1. Stop the motor and lock out the switch.
2. Thoroughly clean and remove grease inlet plug and drain pipe from the outer bearing caps.
3. Add grease to inlet with hand gun until small amount of new grease is forced out drain. Catch used grease in suitable container.
4. Remove excess grease from ports and replace inlet plug only.
5. Run at least one hour to expel any excess grease from drain opening.
6. Clean old grease from drain pipe. Replace cleaned drain pipe and drain plug.
7. Put the unit back in operation.

Lubrication-Sleeve Bearings

Motors with sleeve bearings are shipped without oil. A rust-inhibiting film is applied at the factory to protect bearing and journal surfaces during shipment. Before attempting to operate any sleeve bearing motor, the following steps must be performed.

1. Visually inspect the bearing condition. Oil ring inspection ports and drain opening in the housing are normally provided for this purpose.
2. Check for any accumulation of moisture. If oxidation is discovered all traces of it must be removed before machine is put in service.
3. Flush all oil piping. Fill bearing reservoirs to normal level. The following grades of oil are recommended.

Motor RPM	Oil Viscosity At 100°F	ISO Grade
3600 1800	140 – 160 SSU	32
& slower	290 – 310 SSU	68

NOTE

If oil temperature exceeds 175° on 3600 and 1800 RPM motors, or 150°F on 1200 RPM and slower motors – use the next higher viscosity oil. The oil viscosity at operating temperature is very important in selecting proper oil, and may vary in different climates. If operating temperature is not known, consult factory for suggested oil selection.

4. Oil reservoirs should be filled to mark indicated on gauge or center of gauge.



CAUTION

Improper lubrication can cause equipment damage. Refer to lubrication instructions on motor or in this manual.

5. Rotate shaft several turns by hand to distribute oil over bearing parts. Make sure oil rings rotate freely.

It is important to maintain the correct oil level, as lack of lubrication is often the cause of bearing failure.

Inspect oil level and oil ring operation frequently. Oil ring operation can be observed through the sight glass mounted at the top of the bearing capsule. Oil rings should be perfectly round, free of burrs or rough edges, turn at constant speed and carry a noticeable amount of oil to the top of the journal. Failure of the oil ring to turn freely may be caused by:

1. Ring out of round (should be round to .0062 inch).
2. Fouling on a projection of the bearing bushing.
3. Ring not balanced (heavy side will tend to remain down).
4. Adhesion to guide slot (trapezoidal section reduces adhesion).
5. Oil too cold or viscous, or oil level too high.
6. Shaft not level – oil ring tends to bind.

At the first sign of oil discoloration or contamination, replace with new oil. Rapid discoloration is caused by bearing wear, often from vibration or thrust. Change oil as required to keep clean.

Force Feed Lubrication

Oil is metered through an orifice in oil inlet line to allow the proper amount of lubricating oil to enter the bearing. Conventional oil rings are also supplied with the motor to insure temporary bearing lubrication in the event the force feed oil supply should fail.

Checking Sleeve Bearing Clearance

It is very important to check periodically the clearance of sleeve bearings. Excessive clearance can cause rapid bearing failure, and decreased air gap between stator and rotor at the bottom of the motor.

The normal clearance in a sleeve bearing is 0.002 inch plus 0.001 for every inch of journal diameter.

An accurate check of bearing clearance is obtained with micrometer measurements of the shaft journal and bushing bore. If the ends of the bearing are accessible, the clearances at the ends can be measured with feeler gauges.

Bearing Replacement

For typical bearing configurations, see Figure 5 through 8, page 18.

Antifriction

Replacement bearings may be of a different manufacture but must be equal to the originals used in the motor. When ordering bearings specify as follows:

1. Identifying numerals and manufacturer stamped on the bearing.
2. Bearing tolerance class, i.e. – A.B.E.C.-1 (Annular Bearing Engineers' Committee Tolerance Class One).
3. Electric motor quality.
4. Internal radial clearance, i.e. – A.F.B.M.A.-3 (Anti-Friction Bearing Manufacturers Association, Clearance Class Three).

To Replace Bearings

1. Remove bolts holding bearing housings to yoke.
2. Remove bolts holding end caps to housings.
3. Remove bearing housings.
4. Use bearing puller and exert force only on inner race to remove bearing from shaft.

NOTE

Protect the shaft end with a cap (Figure 4). If bearing is reusable, make certain the puller applies pressure against the bearing inner race only. If puller will not hook the bearing inner race, fabricate a split bushing and install it between the bearing and the puller hooks.

5. Check shaft diameter for proper size with micrometer.
6. Heat the new bearing in an oven (200°F). While it is hot, slide the bearing onto shaft – make certain that the inner race makes a firm even contact with shaft shoulder. Do not subject bearing to impact.
7. Let bearing cool – pack bearing caps with the proper grease.

The amount of grease to be used when repacking a bearing after cleaning or replacement is:

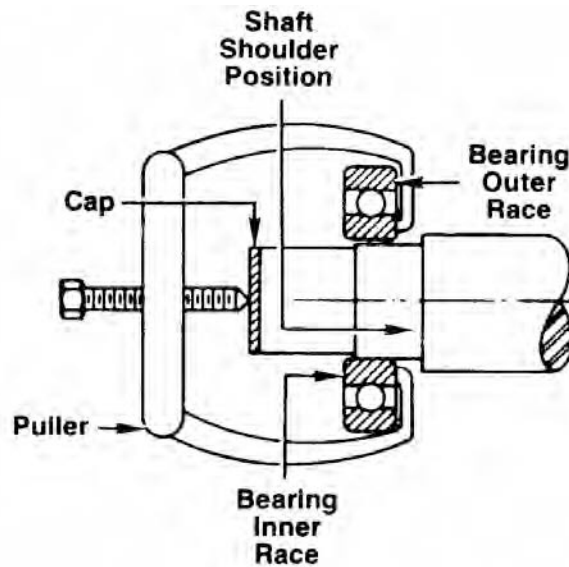


Figure 4. Removing Bearing with a Puller

Type Bearing	Operating Position (Shaft)	Grease Quantity* (End Caps)	
		Outer	Inner
Open Deep Groove	Horizontal	2/3 Full	1/3 Full
Roller	Horizontal	1/3 Full	1/3 Full

*Pack all open bearings full between balls or rollers but remove excess grease on outside of retainers.

8. Reassemble end caps and housings.

Sleeve Bearing

When replacing sleeve bearings, it is always desirable to check the fit (contact pattern) of the bearing to the shaft. When ordering sleeve bearings, be sure to provide complete motor nameplate and bearing data.

Whenever a sleeve bearing is replaced, cleanliness must be observed through every step of the operation.

Always inspect the bearing journal surfaces; they must be smooth and polished. Slight scoring can be removed with crocus cloth. If the motor shaft has been seriously scored it must be put between centers and reground. Journals can be ground 0.001 inch under size, but they must be absolutely round and concentric with shaft center.

Sleeve Bearing Replacement

The replacement of split bearings can often be accomplished without uncoupling the load or otherwise disturbing the installation.

1. Check replacement bearings for nicks or shipping damage. Do not scrape.
2. Remove the upper half of the bearing enclosure.

NOTE: On some motors, the following procedures MUST also be observed.

- Back the bronze rotating slinger out of the bracket groove.
 - Remove all the bearing bracket studs to the yoke. Replace two upper bolts just below horizontal split with longer studs to support bearing bracket when it is free of its yoke fit.
 - Slide the top and bottom bracket halves together axially until the machined fit is clear of the stator yoke.
 - Slide the top and bottom bracket halves together axially until the machined fit is clear of the stator yoke.
3. Remove top half of bearing.
 4. Raise the shaft slightly, rotate lower bearing half 180° and remove the lower half of the bearing.
 5. Reassemble, apply sealant, lubricate, turn motor by hand to be sure of proper fit and oil ring operation.
 6. Start motor without load and check oil ring operation.

End Play – Split Sleeve

Control of rotor end-float in split-sleeve bearing motors is maintained in the drive end bearing. The total end-float is 0.5" minimum. The bearings are located axially by shims or similar devices between bearing bushing and housing shoulders. This permits bearing to be adjusted axially to maintain coincidence of electrical and mechanical centers. Any adjustment of the axial position of the bearing should be accompanied by the same axial adjustment of the opposite end bearing.

The coupling should limit the end float of the shaft to ± 0.19 " from the mechanical center. The limited end-float coupling prevents the rotor from rubbing against the bearing shoulders during operation.

Construction of Bearing Assembly

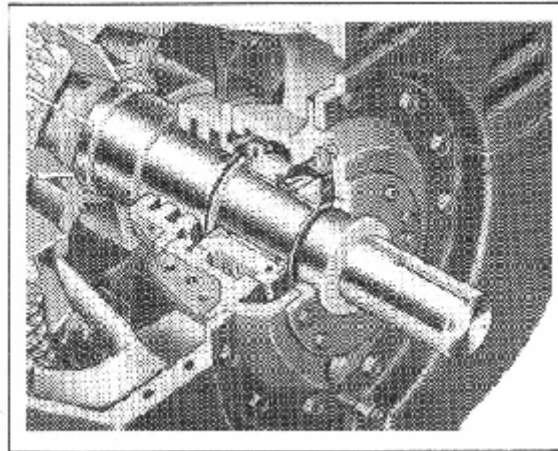


Figure 5. Split Sleeve Bearing Construction
Type G 503 Frame Motor

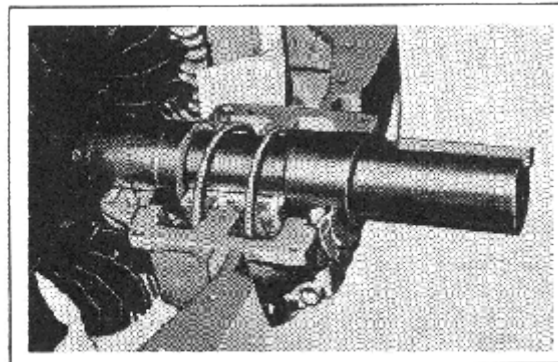


Figure 6. Type RG Split Sleeve Bearing Construction
30 Frame Motors

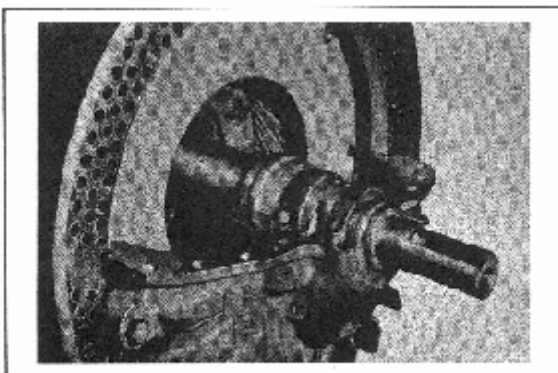


Figure 7. Split Sleeve Bearing Construction
Type AZ Motor

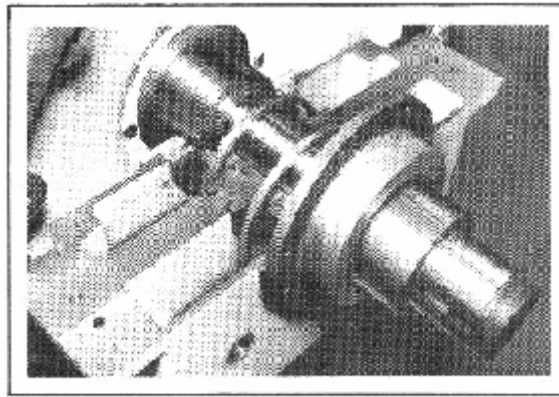


Figure 6. Split Sleeve Bearing Construction with Split Bulkhead, Type AZ(Z)

Stator Removal

Two types of stator construction are employed.

Types AZ and AZZ 30 Motors Type

These motors incorporate a removable prewound stator assembly unit, separate from the frame. The end retaining rings of the stator assembly are machined to fit the stator frame. The stator unit is clamped into the frame by retaining links located at both ends of the unit. The stator unit can be re-wound with the unit mounted in the frame; but it is often easier to remove it. The most practical method is to lift it vertically from the opposite drive end of the frame. There are tapped holes in the end stator rings for this purpose. Form-wound coils are accurately fitted and securely retained in the slots; coil ends are braced securely by coil supports.

All Other Types

The stator assembly of all other types is either a press fit within the stator frame, or it becomes such after the complete assembly has been processed with multiple epoxy vacuum-pressure-impregnation cycles. It is recommended that a new stator frame be furnished with the replacement stator assembly.

Spare Parts

Identification

All units have an identification (name) plate affixed to the frame (Figure 9). All the necessary information pertaining to the machine can be found on this plate.

1. Model and type
2. Frame size
3. Horsepower and Speed
4. Voltage
5. Manufacturer

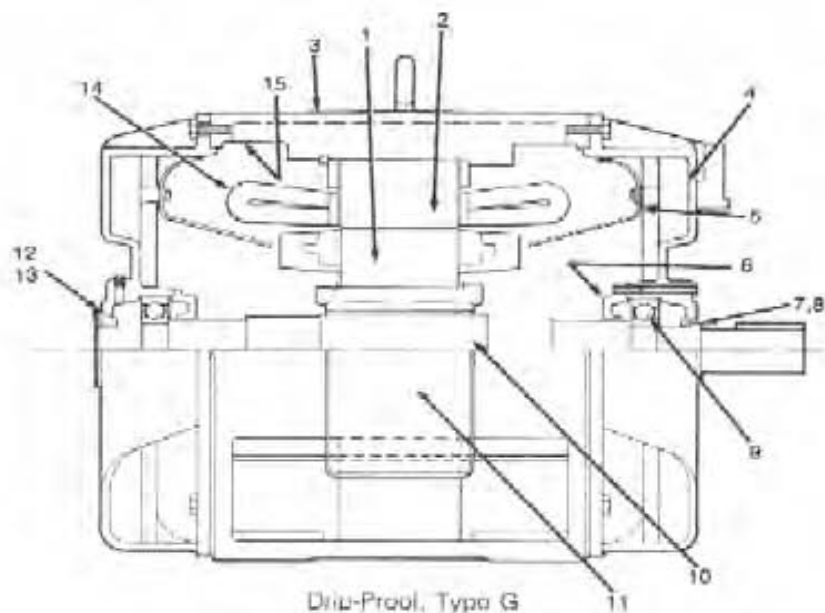
It is important when ordering spare parts or referring to your machine, to record as much data from this plate as possible.

JOLIET		AC MOTOR	
Joliet Equipment Corporation			
HP	RPM	VOLTS	
AMPS	FRAME		
DUTY	HZ	TEMP RISE	C
S.F.	INSUL CLASS	MAX AMBIENT	C
MOD	SER		
CODE	TYPE	MFR	
First in Large Industrial Motors and Drives		JOLIET, ILLINOIS, U.S.A.	
		(815) 727-6606	

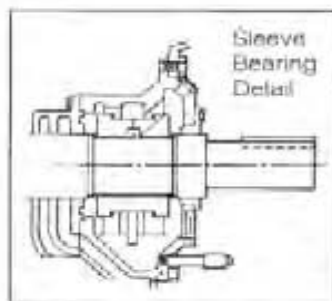
Figure 9. Identification Plates

Parts Identification

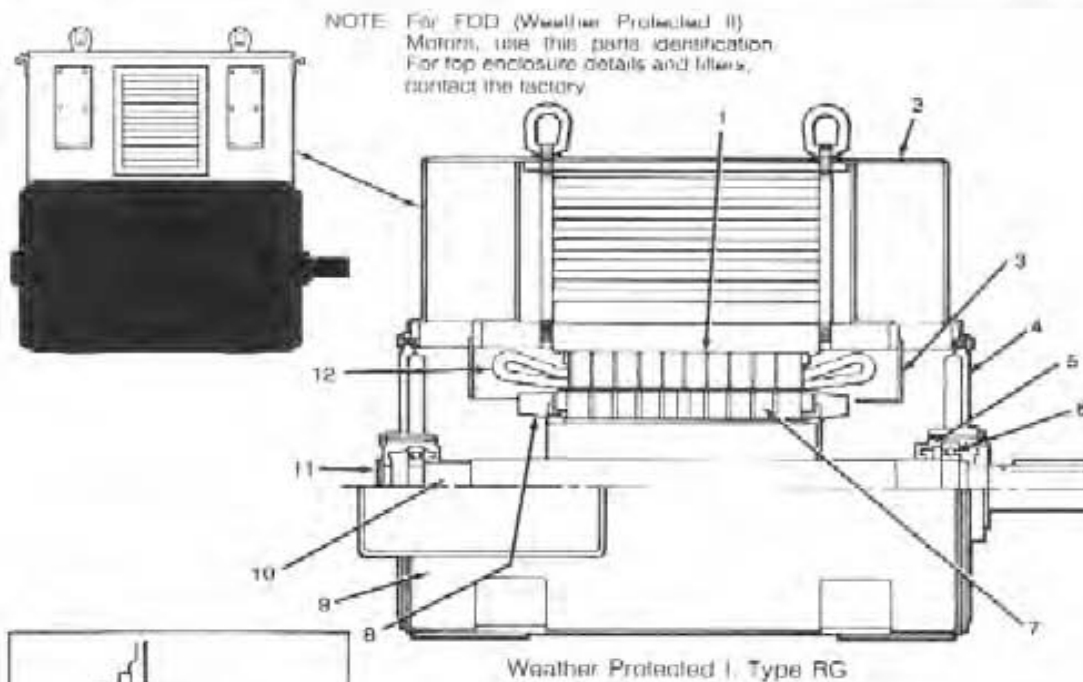
The drawings in this book are of the standard design. Most of the parts should be easy to identify. If however, there is some deviation from your actual machine, consult the factory or the drawings supplied with your unit.



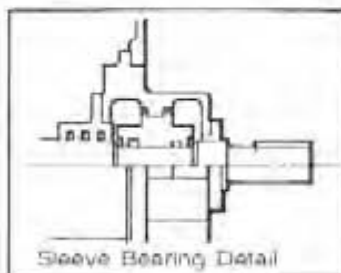
Drip-Proof, Type G



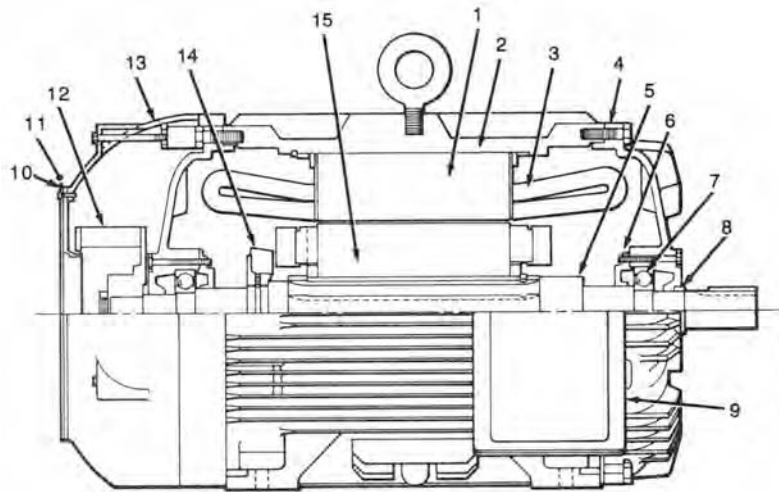
Item	Description	Item	Description
1	Rotor Assembly	9	Ball Bearing
2	Stator Assembly	10	Rotor Shaft
3	Stator Yoke	11	Terminal Box
4	Bearing Housing	12	Dust Cap
5	Air Deflector	13	Dust Washer
6	End Cap	14	Stator Coil
7	Shaft Seal	15	Yoke Baffle Ring
8	Set Screw		



Weather Protected I, Type RG

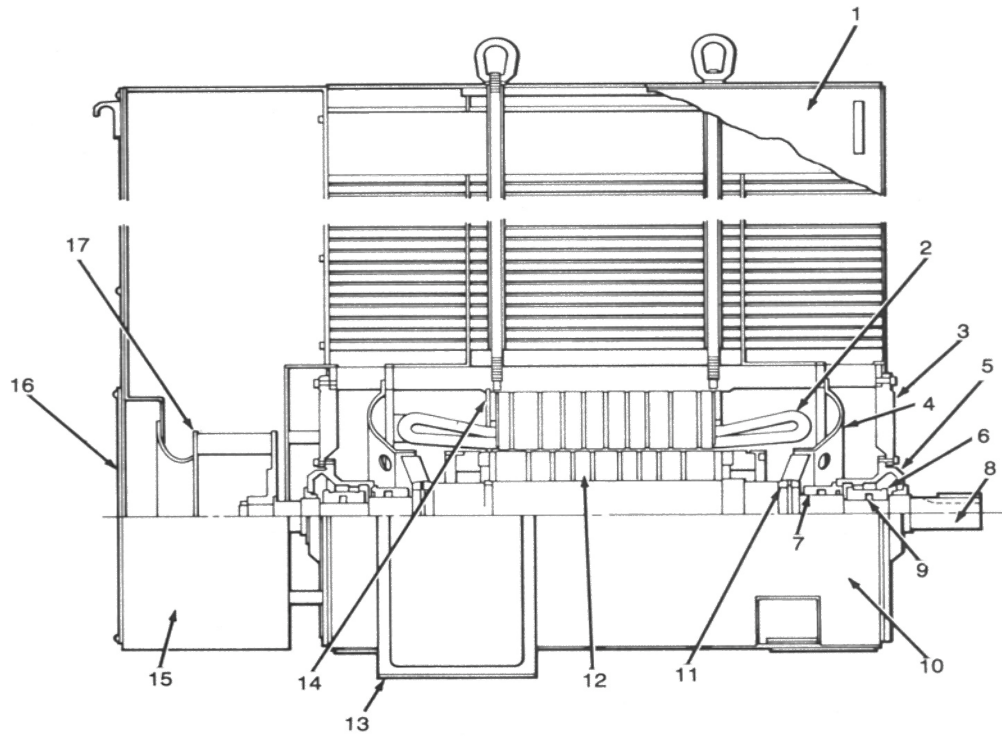


Item	Description	Item	Description
1	Stator Assembly	7	Rotor
2	Top Cover	8	Rotor Fan
3	Air Deflector	9	Stator Yoke
4	Bearing Housing	10	Rotor Shaft
5	End Cap	11	Dust Cap
6	Bearing	12	Stator Coil



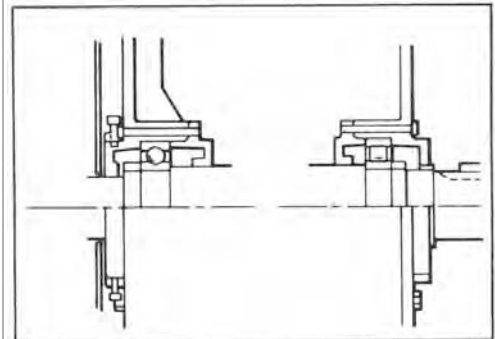
TEFC

Item	Description
1	Stator Core
2	Stator Yoke
3	Stator Coils
4	Bearing Housing
5	Rotor Shaft
6	Inner End Cap
7	Ball Bearing
8	Shaft Seal
9	Main Terminal Box
10	Grid Cover
11	Fan Inlet Baffle
12	External Fan
13	Fan Housing
14	Internal Fan
15	Rotor Core

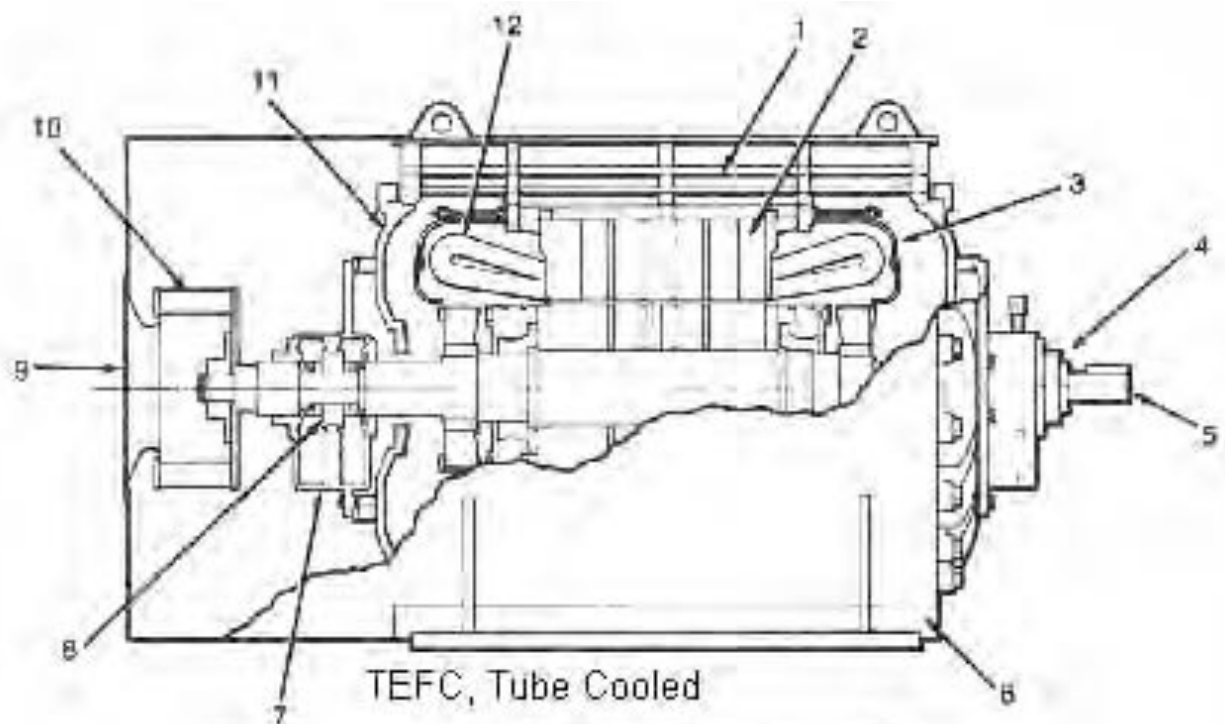


TEFC, TEAAC

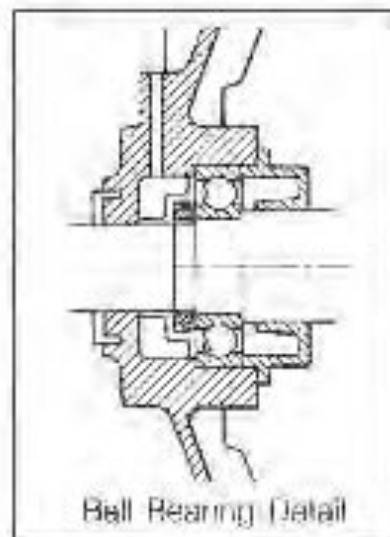
Item	Description
1	Top Cover
2	Stator Coils
3	Bearing Bracket
4	Air Deflector
5	Bearing Cap
6	Split Sleeve Bearing
7	Oil Guard
8	Rotor Shaft
9	Oil Ring
10	Stator Yoke
11	Rotor Fan
12	Rotor
13	Main Terminal Box
14	Snap Ring
15	Fan Housing
16	Grid Cover
17	Fan-External



Ball Bearing and Roller Bearing Detail



Item	Description
1	Cooling Tubes
2	Stator Assembly
3	Air Deflector
4	Outer Oil Guard
5	Shaft
6	Stator Yoke
7	Bearing Capsule
8	Sleeve Bearing
9	Grid Cover
10	Fan
11	Bearing Bracket
12	Stator Coils



Machinery Vibration Severity Chart

For use as a GUIDE in judging vibration as a warning of impending trouble.

For use as a GUIDE in judging vibration as a warning of impending trouble

Vibration Analysis Data Sheet

*Dominant Frequency

Pick-Up		Filter Out-Coupled?			YES	Filter In-Coupled?				YES			
					NO					NO			
Point	Position	Disp.	Freq.*	Vel.	Freq.*	Disp.	Freq.	Disp.	Freq.	Disp.	Freq.	Disp.	Freq.
		Mils	CPM	In/Sec	CPM	Mils	CPM	Mils	CPM	Mils	CPM	Mils	CPM
	Horizontal												
	Vertical												
	Axial												
	Horizontal												
	Vertical												
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	Horizontal												
	Vertical												
	Axial												
	Horizontal												
	Vertical												
	Axial												

Before vibration difficulties are reported, accurate vibration readings should be taken and consideration given to the following:

1. How does vibration level at center line of motor compare to that at motor feet and foundation?
2. Is motor on a fabricated base or grouted in concrete?
3. When power is cut, does the vibration decay immediately or does it gradually die away?
4. Is there a large shim pack under motor feet?
5. Does vibration level change when mounting bolts are loosened one at a time?
Do feet distort when bolts are loosened?
6. Is motor for coupled or belt-driven use? Is a coupling used on a long shaft motor?
If so, how long is the key and what is the length of the coupling?
7. Is there a resonant condition in system which can be checked by a hammer test?

Induction Motors

Horizontal and Vertical Nema
143-449 Frame

Instructions

Installation
Operation
Maintenance

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These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the Sales Office

The contents of this instruction manual shall not become part of or modify any prior or existing agreement, commitment or relationship. The sales contract contains the entire obligation of Joliet. The warranty contained in the contract between the parties is the sole warranty. Any statements contained herein do not create new warranties or modify the existing warranty.

THIS EQUIPMENT CONTAINS HAZARDOUS VOLTAGES, ROTATING PARTS AND HOT SURFACES. SEVERE PERSONAL INJURY OR PROPERTY DAMAGE CAN RESULT IF SAFETY INSTRUCTIONS ARE NOT FOLLOWED. ONLY QUALIFIED PERSONNEL SHOULD WORK ON OR AROUND THIS EQUIPMENT AFTER BECOMING THOROUGHLY FAMILIAR WITH ALL WARNINGS, SAFETY NOTICES, AND MAINTENANCE PROCEDURES CONTAINED HEREIN. THE SUCCESSFUL AND SAFE OPERATION OF THIS EQUIPMENT IS DEPENDENT UPON PROPER HANDLING, INSTALLATION, OPERATION AND MAINTENANCE.



DANGER

For the purpose of this manual and product labels, DANGER indicates death, severe personal injury or substantial property damage will result if proper precautions are not taken.

* (see EASA Handbook pdf download)

Inspection

Care is taken at the factory to assure that the motor arrives at its destination in first class condition. If there is evidence of rough handling or damage in shipping, file a claim at once with the carrier and notify your Sales Office.

Examine the outside of the motor carefully for damage, with particular attention to conduit box, fans, and covers. Inspect and tighten all hardware and accessories which may have become loosened during shipping and handling. Turn the shaft by hand to be sure that it rotates freely. If the motor has been mishandled sufficiently to break external parts, the end shield should also be removed to check for internal damage unless the motor is explosion-proof. See warning below on explosion proof motors.



WARNING

Explosion-proof motors – these motors are constructed to comply with the U.L. Label Service Procedure Manual. When repairing and reassembling a motor that has an underwriter's label, it is imperative that the unit be reinspected and:

1. All original fits and tolerances be maintained.
2. All plugs and hardware be securely fastened.
3. Any parts replacements, including hardware, be accurate duplicates of the original. Repair work on explosion-proof motors can only be done by the original manufacturer or U.L. Certified shops. Violations of any of the above items will invalidate the significance of the U.L. Label.

Storage

Motors must be stored in a clean, dry, well ventilated location free from vibration and rapid or wide temperature variations. If the unit is to be stored longer than three months, consult factory. Ball bearing motors are shipped from the factory properly lubricated and ready to operate. When in storage, the motor shaft must be turned several rotations every month and the bearing relubricated every year. On non-explosion-proof TEFC motors, a removable plug in the bottom of the frame or housing permits removal of accumulated moisture. Drain regularly if storage atmosphere results in formation of condensation.

Installation

Installation must be handled by qualified service or maintenance personnel. The motor foundation must rigidly support all four feet in the same plane. Place shims under the motor feet, as required, so they will not be pulled out of plane when mounting bolts are tightened. All wiring to the motor and control must be in accordance with the National Electric Code and all local regulations. Before drive is connected, momentarily energize motor to check that direction of rotation is proper. For direct drive, accurate alignment is 0.004 inch/ft. (radius to dial indicator = one foot).

Any change in shims requires rechecking alignment. When alignment is within limits, dowel two feet of each unit, when installing flat belt pulley, V-belt sheave, spur or helical pinion or chain drives, be certain that they are within NEMA limitations. Refer to NEMA motor and general standards, MG-1 14.07 and 14.42.



CAUTION

Guard against overloading. Overloading causes overheating and overheating means shortened insulation life. A motor subjected to a 10°C temperature rise above the maximum limit for the insulation may cause the insulation life to be reduced by 50%. To avoid overloading, be sure motor current does not exceed nameplate current when nameplate voltage is applied.

Operation

Repeated trial starts can overheat the motor and may result in motor burnout (particularly for across the line starting). If repeated trial starts are made, allow sufficient time between trials to permit heat to dissipate from windings and rotor to prevent overheating. Starting currents are several times running currents, and heating varies as the square of the current.

After installation is completed, but before motor is put in regular service, make an initial start as follows:

1. Check motor starting and control device connections against wiring diagrams.
2. Check voltage, phase, and frequency of line circuit (power supply) against motor nameplate.
3. If possible, remove external load (disconnect drive) and turn shaft by hand to ensure free rotation. This may have been done during installation procedure; if so, and conditions have not changed since, this check may not be necessary.
 - a. If drive is disconnected, run motor at no load long enough to be certain that no unusual conditions develop. Listen and feel for excessive noise, vibration, clicking, or pounding. If present, stop motor immediately. Investigate the cause and correct before putting motor in service.
 - b. If drive is not disconnected, interrupt the starting cycle after motor has accelerated to low speed. Carefully observe for unusual conditions as motor coasts to a stop.
4. When checks are satisfactory, operate at minimum load and look for unusual condition. Increase load slowly to maximum. Check unit for satisfactory operation.

Electric motors operating under normal conditions become quite warm. Although some places may feel hot to the touch, the unit may be operational within limits. Use a thermo-couple to measure winding temperature when there is any concern.

The total temperature, not the temperature rise, is the measure of safe operation. Investigate the operating conditions if the total temperature measured by the thermocouple placed on the winding exceeds:

230°F (110°C) for class "B" insulation

275°F (135°C) for class "F" insulation

302°F (150°C) for class "H" insulation

Voltage Regulation

Motors will operate successfully under the following conditions of voltage and frequency variation, but not necessarily in accordance with the standards established for operation under rated conditions:

- a. When the variation in voltage does not exceed 10% above or below normal, with all phases balanced.
- b. When the variation in frequency does not exceed 5% above or below normal.
- c. When the sum of the voltage and frequency does not exceed 10% above or below normal (provided the frequency variation does not exceed 5%).

Maintenance

Failure to properly maintain the equipment can result in severe personal injury and product failure. The instructions contained herein should be carefully reviewed, understood and followed. The following maintenance procedures should be performed regularly:

1. [Bearing lubrication](#)
2. [Insulation resistance check](#)
3. [Cleaning](#)

This checklist does not represent an exhaustive survey of maintenance steps necessary to ensure safe operation of the equipment. Particular applications may require further procedures. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local Sales Office.

Dangerous voltage are present in the equipment which can cause severe personal injury and product failure. Always de-energize and ground the equipment before maintenance. Maintenance should be performed only by qualified personnel.

The use of unauthorized parts in the repair of the equipment, tampering by unqualified personnel, or removal or alteration of guards or conduit covers will result in dangerous conditions which can cause severe personal injury or equipment damage. Follow all safety instructions contained herein.

Vertical Motor Thrust Bearings

Top bearings – high external thrust from the driven unit is usually carried by the top bearing or bearings. If replacement is necessary, the new bearing must be the same size and type as the original. Duplex bearings must also be the same type and mounted in an identical manner. When angular contact type bearings are replaced, the new bearing must have the same thrust capacity.

Bottom bearings – grease lubricated lower bearings are adequately lubricated at the factory for at least three months operation. The relubrication procedure is the same as outlined above under "Bearing Lubrication". It is important to maintain the lower cavity full of grease at all times.

Service

For immediate action on your motor problems call Joliet Equipment Corporation, 815-727-6606.

**Joliet Equipment Corporation
P.O. Box 114
Joliet, IL 60434 USA**

(815) 727-6606

First in Large Industrial Motors and Drives

Bearing Lubrication



Do not lubricate motor while in operation, since excess grease will be forced through the bearing and into the motor before it will force its way out of the drain plug. Excess grease accumulation on windings reduces insulation life.

Bearing life is assured by maintaining proper alignment, proper belt or chain tension, and good lubrication at all times.

Prior to shipment, motor bearings are lubricated with the proper amount and grade to provide six months of satisfactory service under normal operation and conditions.

For best results, grease should be compounded from a polyurea base and a good grade of petroleum oil. It should be of No.2 consistency and stabilized against oxidation. Operating temperature range should be from -15°F to $+250^{\circ}\text{F}$ for class B insulation, and to $+300^{\circ}\text{F}$ for class F and H. Most leading oil companies have special bearing greases that are satisfactory.

Relubricate bearings every six months (more often if conditions require), as follows:

1. Stop the motor. Lock out the switch.
2. Thoroughly clean off pipe plugs and remove from housings.
3. Remove hardened grease from drains with stiff wire or rod.
4. Add grease to inlet with hand gun until small amount of new grease is forced out of drain.
5. Remove excess grease from ports, replace inlet plugs, and run motor $\frac{1}{2}$ hour before replacing drain plug.
6. Put motor back in operation.

Insulation Resistance

Check insulation resistance periodically. Any approved method of measuring insulation resistance may be used, provided the voltage across the insulation is at a safe value for the type and condition of the insulation. A hand cranked megger of not over 500 volts is the most convenient and safest method. Standards of the Institute of Electrical and Electronics Engineers, Inc. (IEEE) recommend that the insulation resistance of stator windings at 75°C, measured at 500 volts DC, after one minute should not be less than:

$$\frac{\text{Rated Voltage of Machine} + 1000}{1000} = \text{Insulation Resistance in Megohms}$$

This formula is satisfactory for most checks. For more information, see IEEE Standard No. 43, "Recommended Practice for Insulation Resistance Testing of AC Rotating Machinery".

Cleaning



Do not attempt to clean motor while it is operating. Contact with rotating parts can cause severe personal injury or property damage. Stop the motor and lock out switch before cleaning.

The motor exterior must be kept free of oil, dust, dirt, water, and chemicals. For fan cooled motors, it is particularly important to keep the air intake openings free of foreign material. Do not block air outlet or inlet.

On non-explosion-proof TEFC motors, a removable plug in the bottom center of the motor frame or housing permits removal of accumulated moisture. Drain regularly.

Motor Service Record

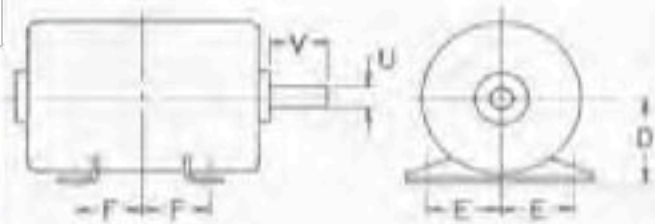
Serial No.	<input type="text"/>	Horsepower	<input type="text"/>	Type	<input type="text"/>
Speed	<input type="text"/>	Volts	<input type="text"/>	Amperes	<input type="text"/>
		Hertz	<input type="text"/>	Model	<input type="text"/>
Insulation Class	<input type="text"/>	Temperature Rise	<input type="text"/> °C	Frame Size	<input type="text"/>
Owner Order No.	<input type="text"/>	Item No.	<input type="text"/>	Date Purchased	<input type="text"/>

MACHINE TYPE		BEARINGS				SHAFT EXTENSION			
Horizontal		Ball	Roller	Sleeve	Length	<input type="text"/>			
Vertical		Size:			Diameter	<input type="text"/>			
Open Drip-Proof		Drive End (DE)	<input type="text"/>		Internal Thread	<input type="text"/>			
Totally Enclosed		Opposite Drive End (ODE)	<input type="text"/>		External Thread	<input type="text"/>			
Explosion Proof		Lubrication	<input type="text"/>		Keyway	<input type="text"/>			
Weather Protected									
Date Installed	Location				Application				
Date Repaired Or Replaced	Repairs or Parts Replaced ⁽¹⁾				Fault		Repaired By		Total Cost
⁽¹⁾ Name of Part	No. Per Machine	Joliet No.	Date	Quan. Repl.	Cost	Date	Quan. Repl.	Cost	Date
Rotor									
Stator Coils									
Bearing. (DE).									
(ODE).									
Other									
.									

INSPECTION												
Date Checked												
Bearings												
Lubrication												
Excess Heat												
Excess Noise												
Speed												
Voltage												
Amps												
Insulation												
Clean												
Alignment												
Vibration												
Temperature												

FRAME CHART, NEMA and T-Frame Chart

FRAME	U	D	E	F	V
42	3/8	2 5/8	1 3/4	2 7/32	1 1/8
48	1/2	3	2 1/8	1 3/8	1 1/2
48H	5/8	3	2 1/8	2 3/8	1 1/2
56	5/8	3 1/2	2 7/16	1 1/2	1 7/8
56H	5/8	3 1/2	2 7/16	2 1/2	1 7/8
66	3/4	4 1/8	2 15/16	2 1/2	2 1/4
143T	7/8	3 1/4	2 3/4	2	2 1/4
145T	7/8	3 1/4	2 3/4	2 1/2	2 1/4
182	7/8	4 1/4	3 3/4	2 1/2	2
182T	1 1/8	4 1/4	3 3/4	2 1/2	2 1/2
184	7/8	4 1/4	3 3/4	2 1/2	2
184T	1 1/8	4 1/4	3 3/4	2 1/2	2 1/2
203	3/4	5	4	2 1/2	2
204	3/4	5	4	3 1/4	2
213	1 1/8	5 1/4	4 1/4	2 3/4	2 3/4
213T	1 3/8	5 1/4	4 1/4	2 3/4	3 1/8
215	1 1/8	5 1/4	4 1/4	3 1/2	2 3/4
215T	1 3/8	5 1/4	4 1/4	3 1/2	3 1/8
224	1	5 1/2	4 1/2	3 3/8	2 3/4
225	1	5 1/2	4 1/2	3 3/4	2 3/4
254	1 1/8	6 1/4	5	4 1/8	3 1/8
254U	1 3/8	6 1/4	5	4 1/8	3 1/2
254T	1 5/8	6 1/4	5	4 1/8	3 1/2
256U	1 3/8	6 1/4	5	5	3 1/2
256T	1 5/8	6 1/4	5	5	3 1/2
284	1 1/4	7	5 1/2	4 3/4	3 1/2
284U	1 5/8	7	5 1/2	4 3/4	4 5/8
284T	1 7/8	7	5 1/2	4 3/4	4 3/8
284TS	1 5/8	7	5 1/2	4 3/4	3
286U	1 5/8	7	5 1/2	5 1/2	4 5/8
286T	1 7/8	7	5 1/2	5 1/2	4 3/8
286TS	1 5/8	7	5 1/2	5 1/2	3
324T	2 1/8	8	6 1/4	5 1/4	5
324	1 5/8	8	6 1/4	5 1/4	4 5/8
324U	1 7/8	8	6 1/4	5 1/4	5 3/8
324S	1 5/8	8	6 1/4	5 1/4	3
326	1 5/8	8	6 1/4	6	4 5/8
326S	1 5/8	8	6 1/4	6	3
326U	1 7/8	8	6 1/4	6	5 3/8
326T	2 1/8	8	6 1/4	6	5
326TS	1 7/8	8	6 1/4	6	3 1/2
364	1 7/8	9	7	5 5/8	5 3/8
364S	1 5/8	9	7	5 5/8	3 1/2
364U	2 1/8	9	7	5 5/8	6 1/8
364US	1 7/8	9	7	5 5/8	3 1/2
364T	2 3/8	9	7	5 5/8	5 5/8
364TS	1 7/8	9	7	5 5/8	3 1/2
365	1 7/8	9	7	6 1/8	5 3/8
365S	1 5/8	9	7	6 1/8	3 1/2
365U	2 1/8	9	7	6 1/8	6 1/8
365US	1 7/8	9	7	6 1/8	3 1/2
365T	2 5/8	9	7	6 1/8	5 5/8
365TS	1 7/8	9	7	6 1/8	3 1/2
404	2 1/8	10	8	6 1/8	6 1/8
404S	1 7/8	10	8	6 1/8	3 1/2
404U	2 3/8	10	8	6 1/8	6 7/8
404US	2 1/8	10	8	6 1/8	4
404T	2 7/8	10	8	6 1/8	7
404TS	2 1/8	10	8	6 1/8	4
405	2 1/8	10	8	6 7/8	6 1/8
405S	1 7/8	10	8	6 7/8	3 1/2
405U	2 3/8	10	8	6 7/8	6 7/8
405US	2 1/8	10	8	6 7/8	4
405T	2 7/8	10	8	6 7/8	7
405TS	2 1/8	10	8	6 7/8	4



FRAME	U	D	E	F	V
444	2 3/8	11	9	7 1/4	6 7/8
444S	2 1/8	11	9	7 1/4	4
444Z	1 7/8	11	9	7 1/4	3 1/2
444U	2 7/8	11	9	7 1/4	8 3/8
444US	2 1/8	11	9	7 1/4	4
444T	3 3/8	11	9	7 1/4	8 1/4
444TS	2 3/8	11	9	7 1/4	4 1/4
445	2 3/8	11	9	8 1/4	6 7/8
445S	2 1/8	11	9	8 1/4	4
445Z	1 7/8	11	9	8 1/4	3 1/2
445U	2 7/8	11	9	8 1/4	8 3/8
445US	2 1/8	11	9	8 1/4	4
445T	3 3/8	11	9	8 1/4	8 1/4
445TS	2 3/8	11	9	8 1/4	4 1/4
447T	3 3/8	11	9	10	8 1/4
447TS	2 3/8	11	9	10	4 1/4
449T	3 3/8	11	9	12 1/4	8 1/4
503U	3 7/8	12 1/2	10	7	10 3/8
503US	2 5/8	12 1/2	10	7	5 1/4
504	2 5/8	12 1/2	10	8	7 5/8
504S	2 1/8	12 1/2	10	8	4
504U	2 7/8	12 1/2	10	8	8 3/8
504Z	1 7/8	12 1/2	10	8	3 1/2
504UU	3 3/8	12 1/2	10	8	9 7/8
504UUS	2 5/8	12 1/2	10	8	4 1/4
505	2 7/8	12 1/2	10	9	8 3/8
505S	2 1/8	12 1/2	10	9	4
505Z	1 7/8	12 1/2	10	9	3 1/8
505U	3 3/8	12 1/2	10	9	10 3/8
505US	2 5/8	12 1/2	10	9	4 1/4
507U	3 3/8	12 1/2	10	11	9 7/8
507US	2 5/8	12 1/2	10	11	5 1/4
509Z	3 7/8	12 1/2	10	14	12 1/2
509US	2 3/8	12 1/2	10	14	4 1/4
584	3 7/8	14 1/2	11 1/2	9	11 5/8
584S	2 3/8	14 1/2	11 1/2	9	4 1/4
585	3 7/8	14 1/2	11 1/2	10	11 5/8
585S	2 3/8	14 1/2	11 1/2	10	4 1/4
586	3 7/8	14 1/2	11 1/2	10	11 5/8
586S	2 3/8	14 1/2	11 1/2	11	4 1/4
587	3 7/8	14 1/2	11 1/2	12 1/2	11 5/8
587S	2 3/8	14 1/2	11 1/2	12 1/2	4 1/4
588	3 7/8	14 1/2	11 1/2	14	11 5/8
588S	2 3/8	14 1/2	11 1/2	14	4 1/4
682	4 7/8	17	13 1/2	9	14 5/8
682S	3 1/8	17	13 1/2	9	6 1/4
683	4 7/8	17	13 1/2	10	14 5/8
683S	3 1/8	17	13 1/2	10	6 1/4
684	4 7/8	17	13 1/2	11	14 5/8
684S	4 7/8	17	13 1/2	11	6 1/4
685	3 1/8	17	13 1/2	12 1/2	14 5/8
685S	4 7/8	17	13 1/2	12 1/2	6 1/4
686	3 1/8	17	13 1/2	14	14 5/8
686S	4 7/8	17	13 1/2	14	6 1/4



GE Industrial Systems

Instructions

Direct-Current
Motors and Generators
Frames CD180AT to CD500AT

Contact:

Joliet Equipment Corporation
1-800-435-9350 or
Fax 1-815-727-6626

SAFETY PRECAUTIONS

WARNING

High voltage and rotating parts can cause serious or fatal injury. The use of electric machinery, like all other utilization of concentrated power and rotating equipment, can be hazardous. Installation, operation, and maintenance of electric machinery should be performed by qualified personnel, in accordance with applicable provisions of the National Electrical Code and sound local practices.

For equipment covered by this instruction book, it is important to observe safety precautions to protect personnel from possible injury. Among the many considerations, personnel should be instructed to:

- Avoid contact with energized circuits or rotating parts,
- Not by-pass or render inoperative any safeguards or protection devices,
- Avoid extended exposure in close proximity to machinery with high noise levels, and
- Use proper care and procedures in handling, lifting, installing, operating and maintaining the equipment.

Safe maintenance practices with qualified personnel is imperative. Before starting maintenance procedures, be positive that:

- Equipment connected to the shaft will not cause mechanical rotation,
- Main machine windings have been disconnected and secured from all electrical power sources, (lock out drive), and
- All accessory devices associated with the work area have been de-energized.

If high potential insulation test is required, procedures and precautions outlined in NEMA standards MG-1 should be followed.

Failure to properly ground the frame of this machine can cause serious or fatal injury to personnel. Grounding of the machine frame and structure should be in accordance with the National Electrical Code and consistent with sound local practices.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation, or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to GE Motors-D M & G.

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_____ *Direct Current Motors and Generators, GEH-3967N*

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Direct Current Motors and Generators, GEH-3967N

DIRECT CURRENT MOTORS AND GENERATORS FRAMES CD180AT – CD500AT

INTRODUCTION

This instruction book covers the CD180AT-CD500AT line of DC motors and generators.

WARNING: High voltage and rotating parts can cause serious or fatal injury. The use of electric machinery, like all other utilizations of concentrated power and rotating equipment, can be hazardous. Installation, operation, and maintenance of electric machinery should be performed by qualified personnel. Familiarization with NEMA safety standards for construction and guide for selection, installation, and use of integral HP motors and generators, the National Electrical Code, and sound local practices is recommended.

RECEIVING

The equipment should be placed under adequate cover immediately upon receipt as packing coverings are NOT suitable for out-of-doors or unprotected storage. Standard factory packing methods **do not** allow for stacking of motors.

Each shipment should be carefully examined upon arrival. Any damage should be reported promptly to the carrier and to the nearest office of GE Motors-DM&G. Shipping damage is not covered under the standard warranty. A claim must be filed with the carrier.

Storage

During installation or when in storage, the machine and its parts must be protected from the following:

1. Dirt of all kinds.
2. Wetness and temperature extremes.

Protection from dirt can be achieved by covering the machine with a tarpaulin or polyethylene sheet or keeping it where the surrounding area is clean.

Protection from wetness and temperature extremes includes moisture from the surrounding atmosphere condensing onto cooler machine surfaces. This condensation on machine surfaces can result in rusting or corrosion and the electrical windings may suffer serious damage.

Where wetness and/or cold conditions are present, the machine and its parts must be protected by a safe reliable heating system which, at all times, will keep the machine temperature slightly above that of the surrounding atmosphere. If a space heater is included in the machine, it should be energized per the voltage specified on the motor nameplate.

Smaller machines shipped in paper cartons are protected from condensing-type wetness by the insulating characteristics of the carton. To avoid sweating where these have been exposed to low temperatures for an extended period, **allow a few hours for the machine and carton to attain room temperature before unpacking.**

Brushes should not remain in contact with the commutator during prolonged storage, because corrosion may occur and later result in flat spots on the commutator. Release the brush springs and lift the brushes, when pro-longed storage occurs.

All exposed machined-steel parts are slushed with a rust preventive before shipment. These surfaces should be examined carefully for signs of rust and moisture, and reslushed if necessary. Once started, rust will continue if the surface is reslushed without first removing all rust and moisture. Rust may be removed by carefully using fine abrasive paper. Slushing compound can be removed by using a suitable solvent such as mineral spirits.

CAUTION: Many motors are shipped with drive end grounding brushes. These brushes and the surfaces they ride on must be free of any slushing compound before operation.

WARNING: Mineral spirits are flammable and moderately toxic. The usual precautions for handling chemicals of this type must be observed. These include:

1. Avoid excessive contact with skin.
2. Use in well-ventilated areas.
3. Take necessary precautions to prevent fire or explosion hazards.

Extreme care must be exercised in removing rust on shaft extensions near shaft seals, since it is difficult, and sometimes impossible, to remove rust from these surfaces without damaging or deforming them.

Burrs or bumps on other machined surfaces should be carefully removed by using a fine file or scraper.

Machines in storage should be inspected, have the insulation resistance checked at frequent and regular intervals, and a log kept of pertinent data.

CAUTION: When stored, it is suggested that the armature be rotating a few revolutions every three months to prevent loss of grease protection on the bearings and races. Loss of grease or oil protection may cause rust.

Long Terms Storage Considerations

1. Provide blocks, such as railroad ties, to store the machine off the ground. This will minimize moisture pickup from the ground and make inspections easier to accomplish. Be sure there is sufficient drainage.
2. Megger the unit before storing and record the values every three months. If the megger reading indicates a decreasing insulation resistance, move the machine to a drier location.
3. Wrap Mylar around the commutator and tape it to itself. Do not tape the Mylar to the commutator.

Rotate the armature every three months to prevent loss of grease protection on the bearings and races. Loss of grease protection causes rust. **Note:** Rotate the armature in the direction which will not snag the Mylar wrapping on the commutator.

**TABLE 1
APPROXIMATE NET WEIGHTS***

FRAME SIZE	ARMATURE WEIGHT		MOTOR WEIGHT	
	Lbs.	kgs.	Lbs.	kgs.
CDL182AT	17	8	80	36
CD186AT	25	11	102	46
CDL186AT	35	16	128	58
CD189AT	45	20	162	74
CD218AT	50	23	240	106
CD219AT	56	25	250	114
CD2110AT	63	29	280	127
CD258AT	78	35	360	164
CD259AT	89	40	400	183
CD287AT	113	51	500	225
CD288AT	130	59	550	250
CD289AT	175	80	660	300
CD2811AT	210	95	790	360
CD327AT	158	72	690	315
CD328AT	181	82	770	350
CD365AT	220	100	750	340
CD366AT	260	120	860	390
CD368AT	300	140	1020	465
CD3610AT	400	130	1310	595
CD3612AT	530	240	1650	750
CD407AT	400	180	1300	590
CDL407AT	400	180	1350	610
CD409AT	500	225	1600	725
CDL409AT	500	225	1650	750
CD4012AT	780	350	3210	1460
CD504AT	590	265	1900	860
CDL504AT	590	265	2070	940
CD506AT	720	330	2290	1040
CDL506AT	720	330	2440	1110
CD508AT	890	405	2810	1275
CDL508AT	890	405	2970	1350
CD5010AT	1200	545	4260	1935

*Approximate weights for typical motors in each frame size. Does not include weights of accessories such as tachometers, blowers, heat ex-changers, etc. For specific weights, refer to certified outline.

Handling

Complete motors or generators can be lifted by using hooks or slings in the lifting lugs on top of the unit. The lifting lugs are designed to safely carry the weight of the individual machine. **Do not lift the machine with the shaft extensions.**

WARNING: Motor-generator sets or units with heavy attachments such as gear boxes or pumps must **NOT** be lifted by using the lifting lugs of the individual machines.

Motor-generator set bases have lifting holes to be used with spreader bars or hooks. Care must be taken in handling to avoid twisting bases. (Refer to **Table 1** for approximate weights of armatures and motors.)

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INSTALLATION

Installation should be in accordance with the National Electrical Code and consistent with all local codes. Coupling, belt, and chain guards should be installed as needed to protect against accidental contact with moving parts. Machines accessible to the public should be further guarded by screens, guard rails, etc., to prevent personnel from coming into contact with the equipment. Fully guarded covers are supplied on motors and generators. Shaft guards are supplied on MG sets.

Totally enclosed and waterproof motors must have all covers securely in place with gaskets intact in order to exclude dirt, oil, and water. It is generally preferred to remove plugs from drain holes at the bottom of the frame to insure that condensation does not collect inside the motor. However, if the installation requires plugs to be installed, they must be removed periodically to make certain that all water is eliminated.

Location/Ventilation

WARNING: The use of electrical equipment in hazardous locations is restricted by the National Electrical Code, Article 500. Original equipment manufacturers and user customers must read, understand, and apply these rules for installation and use of all equipment in such locations and consult local code inspection and enforcement agencies as necessary to insure compliance. Motors listed by Underwriters Laboratories, Inc. for use in specific locations have been designed, tested, and approved for use in such locations only.

Sections 501-8 and 502-8 now permit the use of totally enclosed motors with positive pressure ventilation or totally enclosed inert-gas-filled motors (Class I locations only) when installation and operation conform to certain requirements.

Motors for Class I locations must have leads sealed at the frame exit and an explosion proof conduit box. (Refer to **Sections 501-4 and 501-5.**)

Motors for Class II locations must have leads sealed at the frame exit and a dust-ignition-proof conduit box. (Refer to **Sections 502-4 and 502-5.**)

CAUTION: Silicone vapor may be present and originate from sealing compounds, electrical cables, and room transformers. These sources must be eliminated. Silicone vapor interferes with commutation and high brush wear may result.

Motors and generators should be installed so that they are readily accessible for routine inspection and maintenance. They are suitable for use in ambient temperatures from 0°C (32°F) to 40°C (104°F). An adequate supply of clean, dry room air (at temperatures from 0°C to 40°C) is required for self-ventilated and blown motors. Where motors must operate in dirty, wet, or contaminated environments, protection in the form of filters or totally enclosed construction must be used to insure long life with normal maintenance.

Do not obstruct ventilating openings.

When filters are supplied, service them regularly. Dirty filters shut off ventilating air.

Beware of recirculation. Install motors so that hot exhaust air will not re-enter the motor.

Protection

CAUTION: Windings, commutator, brush rigging, and bearings should be carefully protected during installation to avoid damage from paint spray, weld splatter, welding rod butts, or metal chips from files and grinders. Metal particles which lodge in windings can cause either immediate or premature failures. Paint or oil on commutators can be very detrimental to good commutation.

Mounting

Motors and generators should be mounted on rigid and solid foundations. Level the base (or the machine). Hold-down bolts should be inspected regularly and kept tight. The feet of the machine may be doweled to the foundation plates or base when alignment procedures are completed. Sliding bases, when used, should be securely anchored to the foundation.

Motors are suitable for mounting as ordered. Special assembly of the conduit box, endshields, and covers is provided when the motor is so ordered. **Do not** rotate commutator-end end-shield with respect to the frame, since brush position is affected. (Refer any questions regarding the allowable mounting orientations for you motor to GE Motors-DM&G.)

Alignment

CAUTION: Be sure to align or check alignment carefully on either motors or MG sets. Misalignment can cause excessive vibration, damaging forces on shafts and bearings, and rapid brush wear. Time taken to assure good alignment will be returned in reduced down-time.

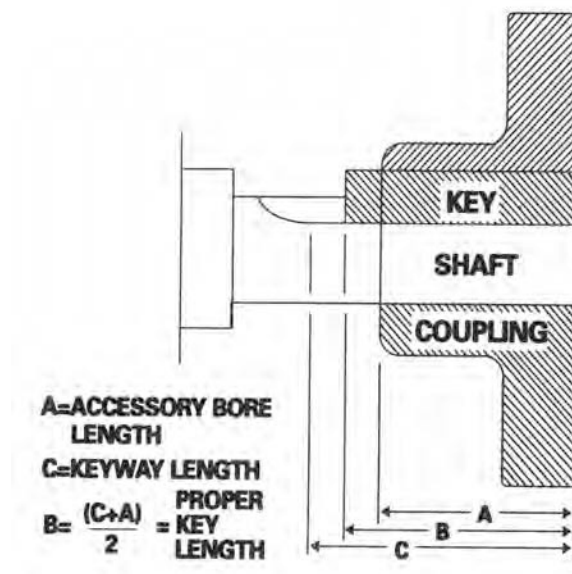


Fig. 1 Selecting the Proper Key Length

Coupled Drive

When a motor and a driven unit together have four or more bearings, flexible couplings must be used to facilitate alignment. Three-bearing construction requires a rigid coupling.

CAUTION: Careful alignment of machines when using either solid (rigid) or flexible couplings is essential to prevent excessive vibration, hot bearings, or shaft failures.

Motors are balanced in the factory using a half-height key of full length. To preserve the original dynamic balance of the motor, select the coupling hub key length "B" according to the formula in Fig. 1.

V-Belt Drives

The V-belt system produces a heavy shaft and bearing loading, making it necessary that these factors be considered carefully for proper application. Since belt drives impose a bending moment on the motor shaft, it is always desirable to have the motor sheave located as close to the motor bearing as possible to minimize both bearing load and shaft stress. This will result in increased bearing life. For the load centered 2" in toward the bearing from the end of the shaft instead of at the end of the shaft, the bearing load is reduced by 10% and the life increased by 33%. The bearing life curves which follow assume that the load is centered at the end of the shaft. New improved V-belts are now on the market that significantly reduce the number and size of belts required for a given load. These new belts should always be considered, since the sheave will be shorter and the load centered closer to the bearing.

It should also be noted that the radial load on the motor bearing is directly proportional to the diameter of the sheave. A larger diameter sheave means **less** radial load on the shaft.

The standard NEMA shaft extension is designed for belted loads. Dimensions are provided on the standard dimension sheets. A sliding base is available as an accessory to facilitate belt adjustment.

Bearing Life

Bearing life for belted drives is determined by calculating the radial load at the end of the shaft.

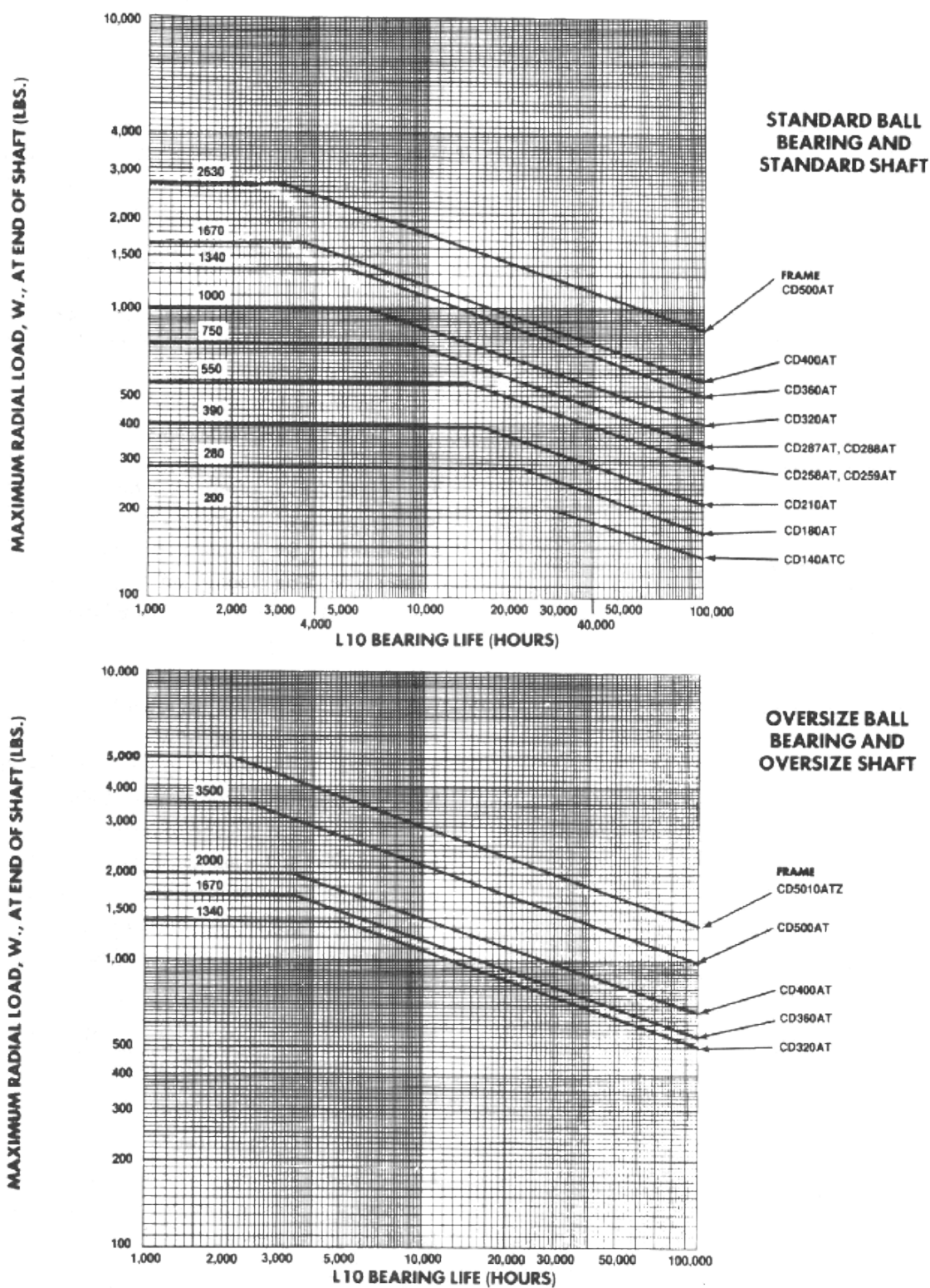


Fig. 2A Bearing Life at 1750 RPM Average Speed vs. Load, W
(For other Average Speeds, multiply Life by 1750/average speed.)

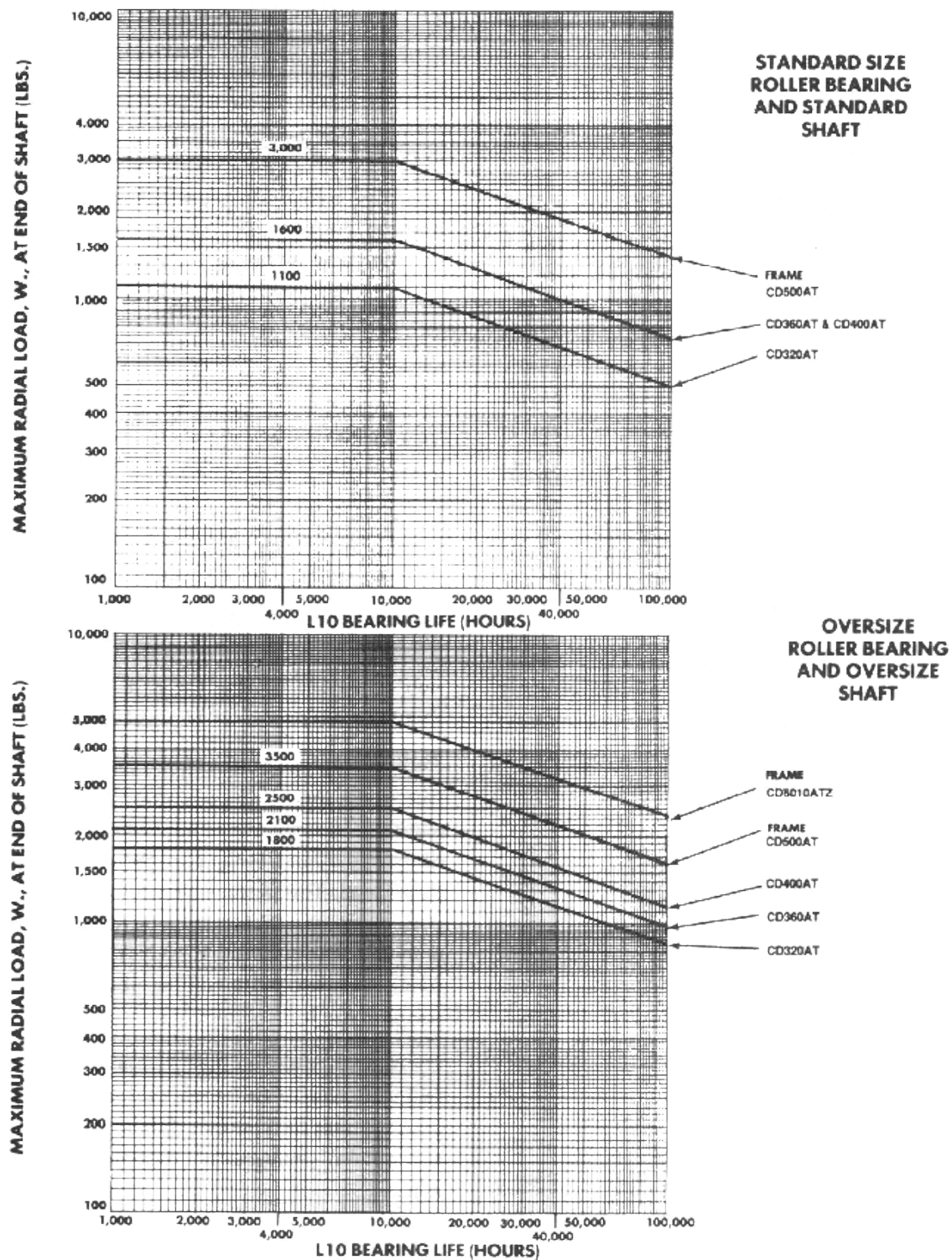


Fig. 2B Bearing Life at 1750 RPM Average Speed vs. Load, W
(For other Average Speeds, multiply Life by 1750/average speed.)

Table 2
BELT TENSION FACTORS

1.0	Chain and Sprocket
1.2	Drive
1.5	Timing Belt
1.8	V-Belt, 1:1 Ratio
2.0	V-Belt, 2:1 Speed
	Decreased Ratio
	Flat Belts

The radial load, "W", produced by the belts, when tightened just enough to transmit the load without slipping, is given by the relation:

$$W = \frac{126,000 \times HP \times K_b}{D \times RPM} \text{ lbs}$$

Where: D = Sheave pitch diameter in inches for V-belt applications.

$\frac{HP}{RPM}$ = Maximum ratio of horsepower, **including overloads**, to the minimum speed at which that power occurs.

K_b = Belt tension factor from **Table 2**

The curves in **Fig. 2** can be used to determine the anticipated L10 life, which is the life in hours that 90% of bearings with this load would be expected to exceed without failure. The standard ball bearing and standard shaft option will be the most economical, if acceptable life is obtained from the curve. A good, commonly used design figure is 20,000 hours. However, calculated life of as low as 5,000 hours has sometimes been necessary for special applications. The curves are drawn for 1750 RPM average speed. If the application has some other average speed, the life can be adjusted by multiplying by the 1750/average speed.

It is important to know that the bearing life for V-belt applications is independent of the motor load. Once the belts have been tightened just enough to prevent slipping when the maximum torque is being delivered by the motor, a radial load, "W", on the shaft and bearing is there and remains constant regardless of the motor load. For timing belts and chain drives, the radial load, "W", does vary somewhat with motor load, and so the motor load duty cycle, as well as the average speed should be considered to estimate bearing life.

For special applications belt tension should be checked and adjusted following the belt manufacturer's recommendations.

If slippage occurs after the belt tension has been correctly adjusted, the belts and pulleys have not been chosen properly for the application.

CAUTION: Over-tightening to avoid this slip-page may result in early failures of belts, shafts, and bearings.

There is normally a drop in tension during the first 24 to 48 hours of operation. During this "run-in" period, the belts seat themselves in the sheave grooves and initial stretch is removed. Belt tensions should be re-checked after a day or two of operation.

Matched belts run smoother, and last longer. Longer belt life results, if the belts and sheaves are kept clean and the belts are prevented from rubbing against the belt guards or other obstructions.

Mounting may be either horizontal or vertical for these bearing life determinations, as long as no axial load other than the weight of the armature is present if vertical.

Special Load Considerations

Where the load is overhung beyond the motor shaft extension or greater bearing life is desired, the application should be referred to GE Motors-DM&G.

Thrust Loads

Due to the mounting position or type of drive arrangement, a thrust load may be applied to the motor shaft. The Kinamatic motor is designed to permit a limited amount of thrust load. This permissible load will vary by mounting position and direction of the load due to the weight of the armature. The permissible load is tabulated in **Table 3** by frame diameter and mounting position. These apply to standard size ball bearings only.

For vertical mounting, the data is tabulated with a plus or minus constant. If the force of the load is acting up (against gravity), then the constant should be plus. If the load is acting down (with gravity), then the constant should be minus.

For applications combining thrust and radial loads or where thrust loads exceed the values shown in the table, refer all details to GE Motors-DM&G.

TABLE 3 THRUST CAPACITY IN POUNDS								
HORIZONTAL MOUNTING					VERTICAL MOUNTING			
RPM					RPM			
FRAME	2500	1750	1150	850	2500	1750	1150	850
CD180AT	145	172	210	240	150±17	175±17	214±17	240±17
CD210AT	190	220	270	310	200±64	240±64	285±64	330±64
CD250AT	225	265	325	370	250±93	285±93	345±93	390±93
CD280AT	300	355	430	490	330±135	380±135	460±135	525±13
CD320AT	355	410	500	580	390±190	460±190	545±190	5
CD360AT	630	740	880	1040	700±335	820±335	970±335	620±33
CD400AT	580	690	840	970	700±526	820±526	970±526	5
CD500AT	890	1050	1310	1510				1110±3 35 110±52 3
					-----REFER TO GE MOTORS-DM&G-----			

Motor-Generator Sets

MG sets are properly aligned before operating a set to be sure that shipping, handling, and installation have not misaligned the units. (Refer to the **Alignment Procedure** section of this Instruction Book.)

Two types of MG set bases are used. One is called "non-self-supporting" and, as the name implies, is not rigid. The non-self-supporting base is designed to act only as a spacer between the foundation and the units of the MG set and must not be trusted to carry any weight unless well supported at all of the mounting pads on its underside. This type of base should be securely bolted to the foundation and, if convenient, grouted in after alignment. Grouting tends to make the base more solid and less liable to later vibration troubles. Be careful not to distort the base during handling or the ability to properly align the MG set will be destroyed.

The other type of base is called "self-supporting" and usually has three pads on its underside forming a three-point support. A self-supporting base is rigid enough so that it needs support only at the pads. The entire weight of the MG set is supported on just these three points and the foundation must be designed to take these high loads.

Two kinds of couplings are used to connect units of MG sets. Some MG sets will be made up of two-bearing units coupled together with flexible couplings. Others will use single-bearing generators connected with rigid (solid) couplings. With each kind of coupling and each kind of base design, a slightly different alignment

Procedure is required. (Refer to the **Alignment Procedure** section of this Instruction Book.)

Grouting

On concrete foundations, a minimum of 1" should be allowed for grouting.

A rich, non-shrink grout should be used. High-grade grout mixtures are available commercially. If the grout is to be prepared at the site, a cement-sand ratio of 1:2 is recommended. Only enough water should be used to give a stiff mixture. The clean, but rough surface of the foundations should be wet and the grout forced or puddled under the base.

Solid Flanged Couplings

Before grouting the base, the alignment should be checked as follows:

1. Loosen all coupling bolts enough to assure that the bolts are not holding the couplings together.
2. Start with the coupling next to the largest unit (usually the motor) or near the middle of a long set, tap the coupling flange with a rawhide or similar non-metallic mallet until the coupling halves separate 0.005" to 0.010".
3. Measure the distance between the coupling faces at four points spaced 90° apart around the coupling rim with a feeler gauge; measuring to the nearest 0.001". The maximum variation between any two readings should not exceed 0.002".
4. Rotate the coupling 90°, 180°, 270°, and 360° and take similar readings. The maximum variation should not exceed 0.002".
5. Correct any misalignment by shimming between the base and the foundation. If shimming between the base and the foundation does not correct misalignment, the unit has moved during shipment and should be shifted on the base.
6. Repeat Steps #2, 3, and 4 on each coupling, working away from the motor or center unit.
7. Recheck the couplings on long sets after completing the above checks, because shimming on subsequent units may affect those already checked. After the set has been aligned within the specified limits, tighten the coupling bolts.

The generators may then be doweled, if desired.

CAUTION: Do not draw the two coupling halves together unless the variation in measurements is 0.002" or less. If there is a variation greater than 0.002", excessive vibration and possible shaft fatigue can occur.

Alignment Procedure

CAUTION: Alignment specifications supplied with couplings are for suitable coupling life. These numbers usually greatly exceed alignment criteria for good bearing life and minimal vibration.

Flexible Coupling

Before grouting the base, the alignment should be checked as follows:

1. Slide the sleeve from the coupling so that the hub faces are exposed.
2. Check that the coupling hub spacing is in accordance with the outline dimensions with the units in the mechanical center of their end play.
3. Start with the coupling next to the largest unit (usually the motor) or near the middle of a long set. Check the radial alignment by using a straightedge across the hubs at both vertical and horizontal locations or by clamping a dial indicator to one hub and indicating the other hub on its outside diameter. Be sure that the dial indicator supports do not bend or sag, since this will give inaccurate readings.
4. Use a dial indicator at hub faces and rotate both units together 90°, 180°, 270°, and 360°, or measure the gap at each position by inserting a feeler gauge. The reading should not vary more than 0.002".
5. Correct any misalignment by shimming between the base and the foundation. If shimming between the base and foundation will not correct misalignment, the unit has moved during shipment and should be shifted on the base.
6. Repeat Steps #2, 3 and 4 on each coupling, working away from the motor or center unit.
7. Recheck the couplings on long sets after completing the above checks, because shimming on subsequent units may affect those already checked. After the set has been aligned within the specified limits, the coupling shells may be bolted together.

The generators may then be doweled, if desired.

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OPERATION

WARNING: Disconnect power before touching any internal part. High voltage may be present even when the machine is not rotating. If used with a rectified power supply, disconnect all AC line connections to power supply. With other power supplies, disconnect all DC line and field connections. Also disconnect power from auxiliary devices.

WARNING: Ground the machine properly to avoid serious injury to personnel. Grounding must be in accordance with the National Electrical Code and consistent with sound local practices. One of the bolts holding the conduit box to the unit, accessible from inside the conduit box, is identified and may be used for attaching a grounding cable.

WARNING: Before starting the motor, remove all unused shaft keys and loose rotating parts to prevent them from flying off.

Inspection Before Starting

These inspection procedures should be followed before starting the machine for the first time, after an extended shutdown, or after a teardown for extensive maintenance or repair.

Bearings and Couplings

Machines with ball or roller bearings are greased at the factory and will need no attention until relubrication is necessary as suggested under the **Maintenance** section. (Refer to **Table II**).

Flexible couplings should be checked to see that they contain the proper amount of lubricant.

Make sure that all grease plugs are tight.

The oil suspended in grease may leak out after extended periods of motor storage. Because of this, it is no unusual to find puddles of oil below the bearings. If the motor has been stored for over six months, the grease drains should be checked to see they are not plugged with a waxy residue. After ensuring the openings are clear and free, a small amount of grease should be pumped through.

Commutator and Brushes

Brushes should be worn in to have at least 85% contact over the brush surface and continuous contact from heel to toe. The commutator surface and undercut mica should be clean and free from dirt, grease, paint spots, or brush dust.

Brushes should be free to move in the holders and all springs should be down and latched. Brush pigtail connections should be tight, and the pigtails should not interfere with the action of the spring or brush and should be clear of any other part of the machine.

Rectified Power Supplies

When DC motors are operated from rectified power supplies, the pulsating voltage and current wave forms effect the motor performance by increasing motor heating and degrading commutation. Because of these effects, it is necessary that the motors be designed or specially selected to suit this type of operation.

The ratings of DC motors intended for operation from rectified power supplies are based upon motor tests using a suitable power supply. The specific characteristics for three-phase rectified power supplies described below in the **Power Supply Identification** section are in common use. For operation of motors from rectified power supplies other than those given in this section, refer to GE Motors-DM&G.

A motor may, under some conditions, be operated from a power supply different from that indicated on the nameplate. Letters used to identify power supplies in common use have been chosen in alphabetical order of increasing magnitude of ripple current. Power supply compatibility can be judged by **Table 4**.

TABLE 4 POWER SUPPLY AVAILABLE						
NP RATING CODE		A	C	D	E	K
A	✓	*	*	*	*	
C	✓	✓	*	*	*	
D	✓	✓	✓	*	*	
E	✓	✓	✓	✓	*	
K	✓	✓	✓	✓	✓	

✓ Compatible Power Supply

* External inductance may be necessary to limit ripple current

Power Supply Identification

The nameplates of DC motors intended for operation from rectified power supplies will be stamped with a Power Supply Identification as described below:

- A. When the power supply used as the basis of rating is one of the four described below, a single letter "C", "D", "E" or "K" will be used to identify it on the nameplate.**

Power Supply Identification Letter "C"

This designates a three-phase, 60 hertz input, full-wave power supply having 6 total (controlled) pulses per cycle. The power supply has no free wheeling and no series inductance added externally to the motor armature circuit inductance. The input line-to-line AC voltage to the rectifier shall be 230 volts for 240 volt DC motor ratings, and 460 volts for 500 or 550 volt DC motor ratings.

Power Supply Identification Letter "D"

This designates a three-phase, 60 Hertz input, semi-bridge power supply having 3 controlled pulses per cycle. The supply has free wheeling with no series inductance added externally to the motor armature circuit. The input line-to-line AC voltage to the rectifier shall be 230 volts for 240 volt DC motor ratings and 460 volts for 500 or 550 volt DC motor ratings.

Power Supply Identification Letter "E"

This designates a three-phase, single-way (half-wave) power supply having 3 total pulses per cycle and 3 controlled pulses per cycle. The power supply has no free wheeling and no series inductance added externally to the motor armature circuit inductance. The input line-to-line AC voltage to the rectifier shall be 460 volts for 240 volt DC motor ratings.

Power Supply Identification Letter "K"

This designates a single-phase, full-wave power supply having 2 total (controlled) pulses per cycle with free wheeling 60 hertz input with no series inductance added externally to the motor armature circuit. The input AC voltage to the rectifier shall be 230 volts for 180 volt DC ratings.

B. When intended for use on a power supply other than "C", "D", "E", or "K", the motor will be identified as follows:

M/N F – V – H – L

Where:

M= a digit indicating total pulses per cycle.

N= a digit indicating controlled pulses per cycle.

F= free wheeling (this letter appears only if free wheeling is used).

V= 3 digits indicating nominal line-to-line AC voltage to the rectifier.

H= 2 digits indicating input frequency in hertz.

L= 1, 2, or 3 digits indicating the series inductance in millihenries (may be zero) to be added externally to the motor armature circuit inductance.

Connections

Terminal connections should be checked against the connection diagram shipped with the machine. Bolted connections must be tight. When fixed termination (terminal boards) is not specified, then the exposed connections should be appropriately insulated. Grounding screws or studs do not need to be insulated. When more than one terminal is marked with the same identification, they **should be** joined in the same connection. (Refer to **Table 5** for identification of winding leads.)

When series leads are not being used (example: a stabilized shunt or a compound wound unit being used as a straight shunt), the lead should be individually insulated. Do **not** connect together.

TABLE 5 LEAD MARKERS	
FUNCTION WINDING	
Armature	A1, A2, A3, A4, etc.
Control signal lead attached to commutating winding – one lead only.	C
More than one signal lead	C1, C2, C3, C4, etc.
Field (shunt)	F1, F2, F3, F4, etc.
Field (series)	S1, S2, S3, S4, etc.
ACCESSORIES & SPECIAL DEVICE MARKINGS	
Blower Motors, Type AN tachometer generator	T1, T2, T3, T4, etc.
Tachometer generator, direct current, to terminal board	A1, A2, A3, A4, etc.
Brake Coil Leads	B1, B2, B3, B4, etc.
Heater, brake space heater	BH1, BH2, BH3, BH4, etc.
Brake interlock switch	BS1, BS2, BS3, BS4, etc.
Heater, space heater in the machine	H1, H2, H3, H4, etc.
Thermostat	P1, P2, P3, P4, etc.
Resistance Temperature Detector (RTD)	R1, R2, R3, R4, etc.

Protective Devices

See that all protective devices (overspeed devices, bearing temperature relays, etc.) are connected and will function properly. Be sure all coupling guards, shaft protectors, ground connectors, covers, and other safety devices are properly attached.

CAUTION: Motor Field Heating– Unless specifically ordered, motors are **NOT** capable of continuous standstill excitation at rated field current. When the motor is shut down for more than 30 minutes, one of the following options must be used:

1. De-energize the fields completely.
2. Use field economy relays to limit the field current to a maximum of 50% of the name-plate rating.
3. When applicable, fields may remain fully energized if the motor ventilation system (blower or customer duct) remains in operation.

Thermostats

The thermostat is a device that may be used in alarm or protective relay circuits within rating limits shown in **Table 6**. It is not intended to limit motor loading or provide normal insulation life. When supplied, it is mounted in contact with a commutating coil which is the only accessible part of the armature circuit. Since factors such as shaft speed, ventilation (blower or shaft fan), current ripple (SCR phase-back), and short-time overload affect the temperature relationship between the armature and commutating field, complete protection from all conditions resulting from over-temperature is not possible. The device is especially useful in guarding against loss of normal ventilation air, high ambient temperature, and prolonged operation of self-ventilated motors at very low speeds.

WARNING: Thermostats automatically reset after the motor has cooled somewhat. In order to prevent property damage or injury to personnel, the control circuit should be designed to prevent the automatic starting of the motor when the thermostat resets.

TABLE 6
MAXIMUM CURRENT RATINGS FOR SPEED LIMIT SWITCHES & THERMOSTATS ON
DRIPPROOF & TOTALLY ENCLOSED MOTORS
(Normally open or normally closed contacts)

LOAD	125 VAC	250 VAC	600 VAC	30 VDC
Do not use above 600 VAC or 30 VDC				
Resistive	5 AMPS	2.5AMPS	1 AMP	5 AMPS
*Inductive	3 AMPS	1.5AMPS	0.5AMP	1.5AMPS
*Suitable for pilot duty only (relay coils)				

Speed Limit Device

The standard mechanical speed limit device is non-adjustable. Tripping speed is specified by a note on the print certification for each specific order and on the motor nameplate.

The speed limit electrical contacts are normally closed and are usually connected in relay or holding circuits. Current ratings are the same as **Table 6**.

WARNING: The contacts of the speed limit device automatically reclose after the speed has fallen below the trip value. In order to prevent property damage or injury to personnel, the control circuit should be designed to prevent reenergizing the motor until the cause of the overspeed has been corrected.

Space Heater

When furnished, refer to the **Print Certification for Electrical Rating** or the motor nameplate.

WARNING: The surface of a space heater block becomes hot when the heat is energized. The temperature rise above the ambient temperatures may be as high as 400°C. Avoid touching heater blocks which have recently been energized to prevent burns. Also, to prevent fire or explosion, ignitable dust or lint should not be allowed to collect around the surface of the heaters.

Ventilation System

Blowers or central systems must be in operation to supply cooling air before loading force-ventilated machines. Air filters should be in place. Blowers should be checked for correct rotation. (Refer to **Fig. 3** for correct direction of rotation.)

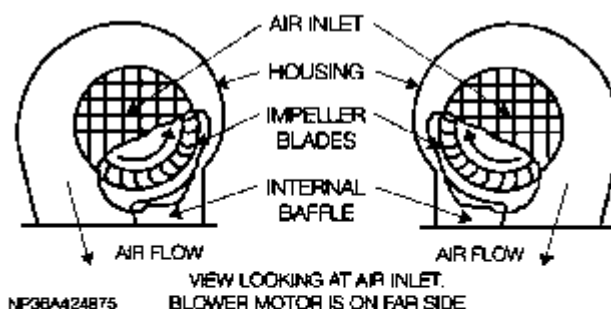


Fig. 3 Correct Arrangement of Blower Housing, Impeller Blades and Direction of Rotation to Obtain Proper Pressure and Air Flow

AC Blower Motors (If Equipped)

CAUTION: Remove drain plugs from the frame or endshields of enclosed motors used outdoors or in other high moisture areas.

Mounting

When bases are removed on enclosed motors, the enclosure must be maintained by plugging the bolt holes with the plastic plugs from Kit No. 1821BPK1.

WARNING: Do not replace the bolts in the frame with the base removed.

Power Supply and Connections

The nameplate voltage and frequency should agree with power supply. Motors will operate satisfactorily on line voltage within + - 10% of the nameplate value or frequency within + - 5% combined variation not to exceed + - 10%.

Dual voltage motors can be connected for the desired voltage using instructions on the nameplate or connection diagram.

Wiring of motor, control, overload protection, and grounding should meet the National Electrical Code and local building codes.

Maintenance

Inspection

Inspect the motor at regular intervals. Keep motor clean and ventilating openings clear.

Lubrication

Ball bearing motors are adequately lubricated at the factory. Motors, if equipped with grease fittings, should be relubricated at intervals consistent with type of service (refer to **Table 7**) to provide maximum bearing life. Excessive or too frequent lubrication may damage the motor.

Relubricate the motor with GE-D6-A2C5 grease unless special grease is specified on the nameplate. For best purging of old grease,, relubricate while the motor is warm and the shaft stationary.

WARNING: Do not relubricate while the motor is running.

Remove caps on the fan cover for access to the grease plugs. On the drive end and opposite drive end of motors with pipe plugs, insert a lubrication fitting. Remove the other plug for grease relief of all motors. Clean grease relief opening of any hardened grease. Be sure fittings are clean and free of dirt. Using a low pressure, hand operated grease gun, pump in clean recommended grease until new grease appears at the relief hole. After relubricating, allow the motor to run for ten minutes before replacing relief plug.

**TABLE 7
BLOWER MOTOR LUBRICATION GUIDE**

Type of Service	Typical Examples	HP Range	Lubrication Interval	
			Horizontal	Vertical
S T A D A R D	1 or 2 Shifts	.5 – 7.5	7 yrs.	3 yrs.
Severe	Continuous Duty and/or Severe Vibration	.5 - 7.5	4 yrs.	1.5 yrs.
Very Severe	Dirt and Vibration and/or High Ambient	.5 – 7.5	9 mos.	6 mos.

Motor Windings

To clean motors, use a soft brush and, if necessary, a slow acting solvent in a well ventilated room.

WARNING: Do not use solvents on windings of the DC motor.

Brake

Flange-mounted brakes may be mounted on the accessory rabbet. Since the accessory stub shaft is not suitable for use with a brake, the standard NEMA commutator end shaft extension should be ordered when such use is planned. Standard brakes are designed for horizontal floor mounting only. When motors are sidewall or ceiling mounted, the brake must be reassembled to maintain its relation to the horizontal. Where motors are to be mounted with the shaft vertical up or down, special brakes should be specified. Brakes used on severe applications, such as outdoor gantry cranes, have many special features.

WARNING: Improper selection or installation of a brake and/or lack of maintenance may cause brake failure which can result in damage to property and/or injury to personnel. **Brake questions should be referred to G.E. Motors-DM&G or the brake manufacturer along with the brake model and serial number.**

General Mechanical Inspection

Check the inside of the machine for tools, metal chips, or any other foreign material that may have accumulated during storage or installation. Make sure that all rotating parts have clearance from any stationary parts. Turn the machine over by hand, if possible, and check for scraping noises or any other signs of mechanical interference. Check the tightness of the bolts in the feet, couplings, bearing housings, and any other bolts that may have been disturbed. (Refer to **Table 8.**) Also check the torque of the yoke bolts. When non-metallic parts or brush holders are bolted to metallic parts use the reduced torque from Table 8A.

Check the tightness of the main and commutating pole bolts (as listed in **Table 9**) at start-up. Loose pole bolts could be a source of objectionable noise when motors are supplied from rectified power. Also check the torque of the yoke bolts.

TABLE 8 GRADE 5 HARDWARE TORQUE VALUES			
BOLT THREAD SIZE (inches)	HEX HEAD DIMENSION	TORQUE LB. FT.	
1/4 - 20	7/16	7 TO 9	
5/16 - 18	1/2	13 TO 30	
3/8 - 16	9/16	24 TO 17	
1/2 - 13	3/4	60 TO 75	
5/8 - 11	15/16	120 TO 150	
3/4 - 10	1 1/8	210 TO 260	
1 - 8	1 1/2	460 TO 580	

TABLE 8A NON-METALIC PARTS AND BRUSH HOLDERS			
BOLT THREAD SIZE (inches)	HEX HEAD DIMENSION	TORQUE LB. FT.	
1/4 - 20	7/16	5 TO 7	
5/16 - 18	1/2	7 TO 9	
3/8 - 16	9/16	13 TO 17	
1/2 - 13	3/4	24 TO 30	
5/8 - 11	15/16	60 TO 75	

TABLE 9 COMMUTATING AND MAIN POLE BOLT TORQUE			
FRAME	BOLT SIZE	TORQUE (lb ft)	
		A	B
CD180AT	3/8 - 16	24 - 30	16 - 20
CD210AT	3/8 - 16	24 - 30	16 - 20
CD250AT	3/8 - 16	24 - 30	16 - 20
CD280AT	1/2 - 13	60 - 75	36 - 45
CD320AT	1/2 - 13	60 - 75	36 - 45
*CD360AT/CD400AT	3/8 - 16	35 - 42	23 - 28
**CD360AT/CD400AT	3/8 - 16	24 - 30	16 - 20
CD500AT	1/2 - 13	60 - 75	36 - 45

A. For steel bolts when assembled without lubricant (dry threads). B. For steel bolts when assembled with lubricated threads			
*6 radial slashes on bolt head. (Grade 8) **3 radial slashes on bolt head. (Grade 5)			

CAUTION: Standard motors, as shipped, are assembled with bolts without lubricant (dry threads). Bolts may be replaced when necessary with bolts with dry threads, or with bolts lubricated with a motor oil or other suitable thread lubricant. When lubricated threads are used, the lower torque values in **column B** will apply. The higher torque values in **column A**, when applied to bolts with lubricated threads, can cause excessive bolt tension and possible bolt breakage.

Accessory Mounting

Provisions for mounting accessories on the commutator end shield is a standard feature on frames CD210AT and above. The rabbit has NEMA Type FC face mounting dimensions, including the mounting bolt holes as shown in **Fig. 4**. The standard stub shaft also permits coupling certain accessories.

WARNING: To prevent injury from rotating shaft, the stub shaft cover must be maintained in position when the accessory mounting is not used.

Standard accessories are available as kits. These include a variety of tachometers and speed limit switches. A mounting adapter, which can be machined for various accessories, can be ordered separately.

Inspection After Starting

The following items should be checked after the machine is running:

Bearings

Ball-bearing or roller-bearing housing temperature should not be more than 80°C (176°F). Check alignment and lubrication if temperature exceeds this limit. **Do not over grease.** (Refer to the **Regreasing Procedure** section of this Instruction Book.)

Noise and Vibration

Check for unusual vibration or noises that might indicate rubbing or interference.

Vibration of new machines at the bearing housings, as measured by a vibration meter, should not exceed the values shown in **Table 10**. (The motor is mounted alone on rubber per NEMA method.)

The most likely cause of vibration in new machines is misalignment due to improper installation, loose foot bolts, uneven shimming under feet, or damage to machine during shipment or installation. Current ripple due to rectified power supply may also be a source of vibration and audio noise.

TABLE 10 VIBRATION VALUES	
RPM	MAXIMUM AMPLITUDE IN INCHES (PEAK TO PEAK)
3000 – 4000 incl.	.001
1500 – 2999 incl.	.0015
1000 – 1499 incl.	.002
999 and below	.0025

Inspection After Short Time in Service

New machines may smell warm or have the odor of varnish, but should not smell scorched.

After a machine has been operating for a short time, an inspection should be made to ascertain that there have been no changes since installation. Re-torque all main and commutating pole bolts. (Refer to [Table 9](#).) Also check the torque of the yoke bolts. (Refer to [Table 8](#).) Check for increased vibration, signs of change in alignment or foundation settling, bolts that may have loosened, rubbing parts, loose connections, and worsened commutation, and take the proper steps to correct the trouble. Also, check condition of air filters on blower ventilated machines. The amount of dirt in the air varies widely between installations.

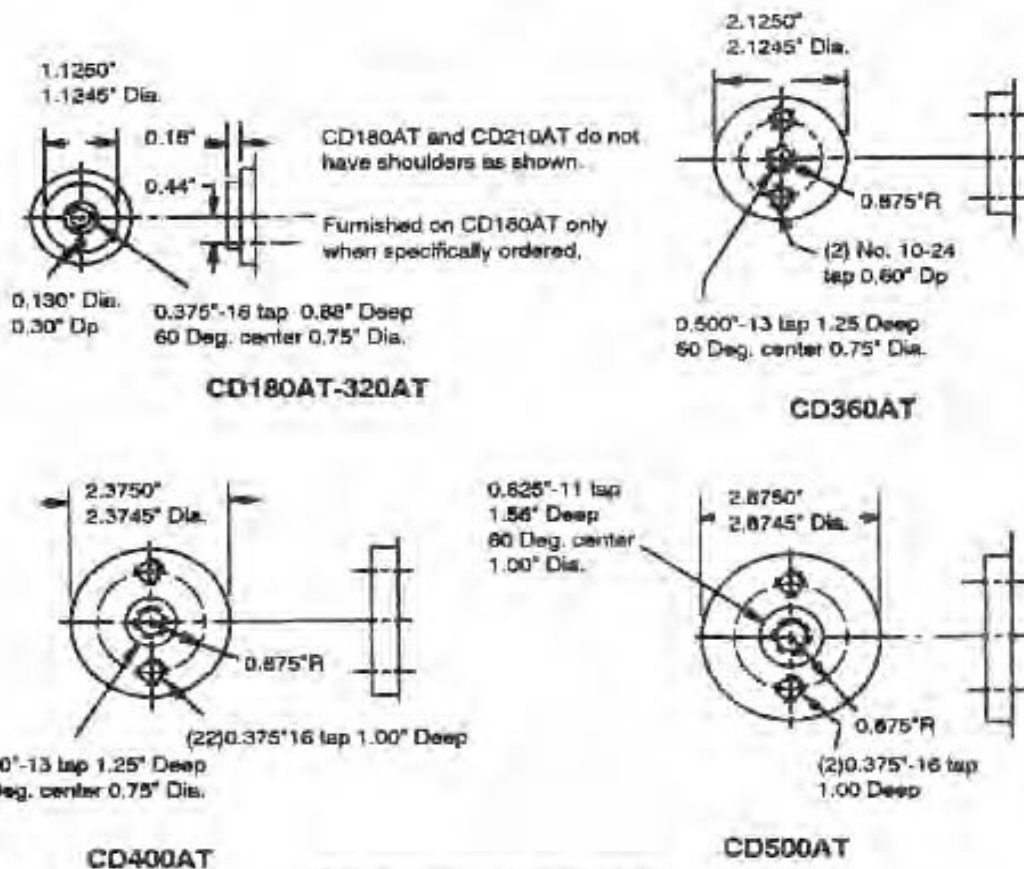
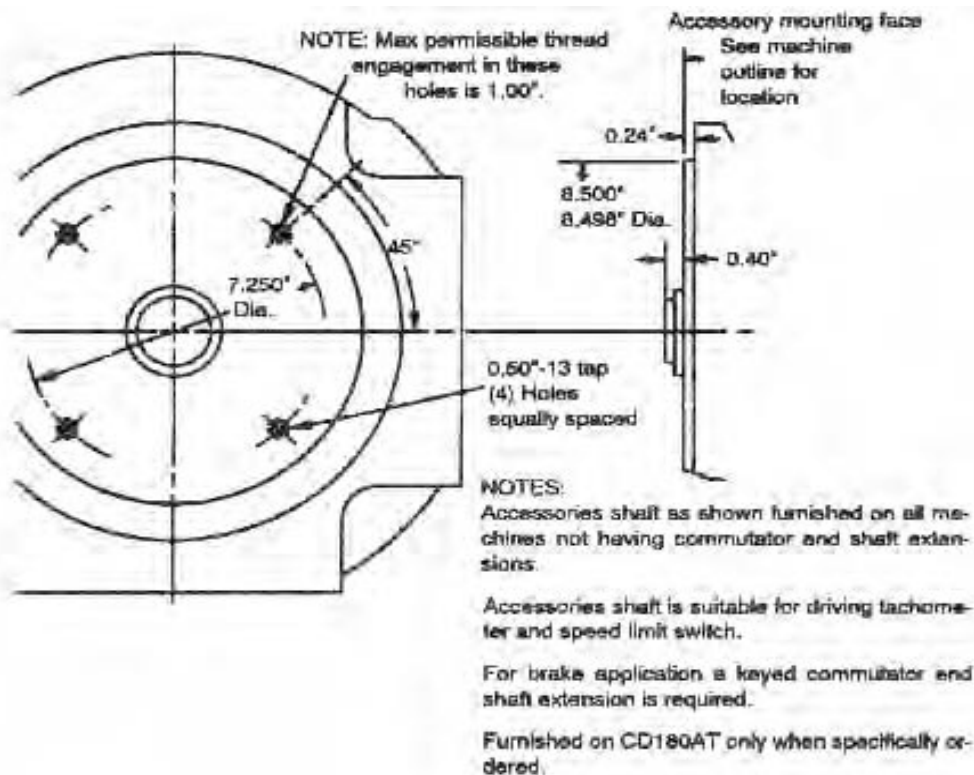
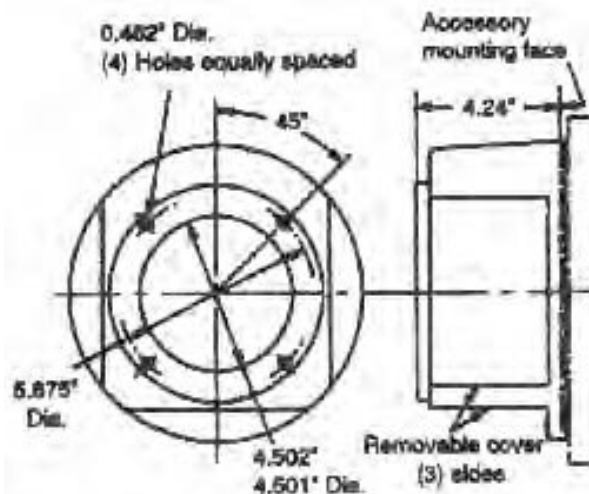


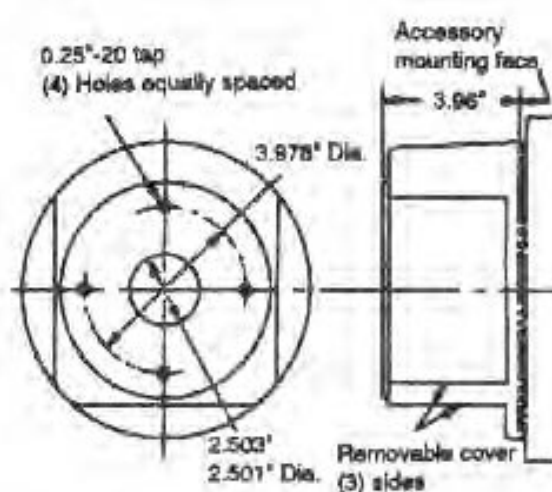
Fig. 4A

Accessory Mounting CD180AT - CD500AT



BC42/BC48 Tachometer adapter
mounts on bracket shown in Fig. 5A.

Fig. 4B



Form "Y" Tachometer adapter
mounts on bracket shown in Fig. 5A.

Fig. 4C.

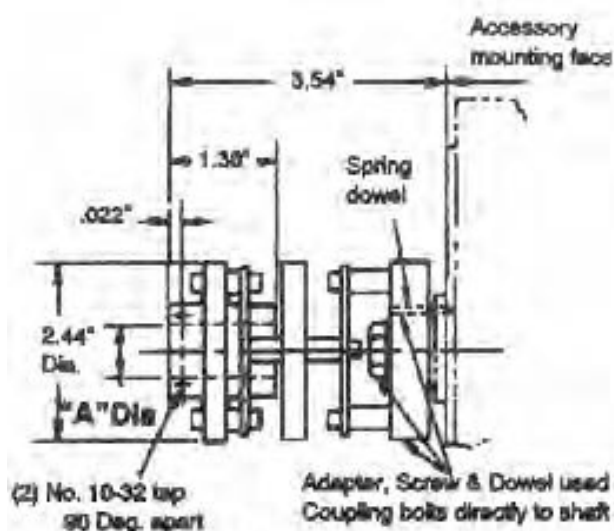


Fig. 4D

"A"	KEY WAY	
	WIDTH	DEPTH
.6255 .6250	.1875	.0937
.7505 .7500	.1875	.0937
.5005 .5000	OMIT	
.3130 .3125	OMIT	

Torsionally rigid coupling rated at
.17 HP per 100 RPM.

Adapter, Screw & Dowel used on CD210AT-320AT only.
Coupling bolts directly to shaft on CD380-500AT.

Fig. 4B-D Accessory Mounting CD180AT - CD500AT

Direct Current Motors and Generators, GEH-3967N

MAINTENANCE

WARNING: High voltage electric shock may cause serious or fatal injury. Disconnect power before touching any internal part. High voltage may be present even when the machine is not rotating. If used with a rectified power supply, disconnect all AC line connections to power supply. With other power supplies, disconnect all DC line and field connections. Also, disconnect power from auxiliary devices.

WARNING: Ground the machine properly to avoid serious injury to personnel. Grounding must be in accordance with the National Electrical Code and consistent with sound local practices.

WARNING: Replace covers and protective devices before operating.

Bearings (Frames CD180AT-CD210AT)

Double shielded bearings are standard in these frame sizes. The bearings are lubricated by the bearing manufacturer and are not regreasable. These bearings should be replaced whenever the motor is disassembled for servicing.

Bearings (Frames CD250AT-CD500AT)

Bearing housings are packed with grease at the factory. Greasing is not required before the motor is put into service. Since the oil in the grease will ultimately become depleted, it is necessary to relubricate bearings periodically depending on the frame size of the motor, average operating speed, and the type of bearing (ball or roller). (Refer to **Table 11.**)

Motors operating in ambient temperatures above 40°C should reduce interval listed in **Table 11** by half.

TABLE 11 RECOMMENDED REGREASING PERIODS			
	RELUBRICATION INTERVAL IN HOURS OF OPERATION		
FRAME SIZE	AVERAGE RPM	BALL BEARING	ROLLER BEARING
CD250AT, CD280AT & CD320AT	500	36000	18000
	1150	15000	7500
	1750	10000	5000
	3000	5000	2500
CD360AT & CD400AT	500	30000	15000
	1150	12000	6000
	1750	6000	3000
	3000	2500	1250
CD500AT & CD 5010AT	500	25000	12500
	1150	8000	4000
	1750	4000	2000
	2000	2600	1300

For best lubrication results, regrease with GE grease No. D6A2C5 or an equivalent lithium base ball bearing grease. (Refer to **Table 12**.) Avoid mixing different kinds of grease. Lubricate motor at standstill. Make sure the grease relief plug (relief pipe on fan-cooled motor). Free the relief hole from any hard-ened grease. Use a hand-operated grease gun only. Pump in grease until new grease appears at lower grease hold. (Insert pipe occasionally on fan-cooled motors to check for appearance of new grease). After greas-ing, allow motor to run about ten minutes be-fore replacing grease relief plug (or pipe) to permit excess grease to drain out.

CAUTION: If a large amount of grease is pump-ed into the motor and none appears at the drain, then remove the handhole covers and visually inspect the area where the shaft protrudes thru the cap and endshield for grease leakage. This would indicate that the drain is plugged up. If this occurs, then remove bearing cap and clean all dried grease out of the cavity and drain hole. Refill 1/3 full. Be sure to wipe away any grease leakage before reassembling the handhole covers. Repeat cleaning after 12 – 24 hours of operation.

Replacement of Bearings

After the bearing brackets have been removed, a bearing puller may be used to pull the bearings from the shaft. Protect the shaft center while using the puller. On frames CD360AT through CD500AT, it may be necessary to remove the bearing retaining snap ring before pulling the bearing. Dis- card the old bearing. The new bearing and all mating parts should be kept extremely clean during reassembly. (Refer to **Table 13** when selecting replacement bearings.)

To install a new bearing, heat the bearing to 116-127°C (240-260°F) in oil or in an oven. Then slip or press the bearing on the shaft. The bearing should be mounted tightly against the shoulder on the shaft.

After the bearing has cooled, re-install the retaining ring where used. Fill the grease reservoir in the inner bearing cap or cartridge 1/3 to ½ full of grease. Butter the bearings and fill the grease reservoir in the bearing bracket 1/3 to ½ full of grease.

WARNING: Extreme pressure (EP) greases should not be used in DC machines. Insulation deterioration and increased brush wear may result from the presence of silicones.

**TABLE 12
SOURCES OF SUPPLY FOR BEARING GREASES**

Temperature	GE Designation	Supplier	Supplier's Designation
<u>STANDARD TEMPERATURE</u> 15°F to 212°F	D6A2C5	G.E. Supply 158 Gaither Drive Mt. Laurel, NJ 08054 1-800-341-1010	GE Ball Bearing Grease (supplied in small tubes and cans)
		Shell Oil Company P.o. Box 2463 One Shell Plaza Houston, TX 77002 (713) 241-4201	Alvania No. 2
		Texaco, Inc. 200 Westchester Avenue White Plains, NY 10650 (914) 253-4000	Regal AFB-2
<u>LOW TEMPERATURE</u> -60°F to 200°F -51°C to 93°C	D6A4	Shell Oil Company P.O. Box 2463 One Shell Plaza Houston, TX 77002 (713) 241-4201	Aeroshell No. 7
<u>HIGH TEMPERATURE</u> -20°F to 350°F -28°C to 176°C	D6A2C13	Standard Oil Company 225 Bush Street San Francisco, CA 94120 (415) 894-7700	Chevron "SR1 II"

**TABLE 13
STANDARD BALL BEARINGS FOR KINAMATIC MOTORS***

NEMA FRAME DIAMETER	STANDARD COMM END BEARINGS	AFBMA#	STANDARD DRIVE END BEARINGS	AFBMA #
180AT	6206	30BC02JPP3	6206	30BC02JPP3
210AT	6206	30BC02JPP3	6207	35BC02JPP3
250AT	6207	35BC02X3	6209	45BC02X3
280AT	6209	45BC02X3	6210	50BC02X3
320AT	6210	50BC02X3	6211	55BC02X3
360AT	6211	55BC02X3	6213	65BC02X3
3610AT	6211	55BC02X3	6214	70BC02X3
3612AT	6213	65BC02X3	6214	70BC02X3
400AT	6213	65BC02X3	6214	70BC02X3
4012AT	6214	70BC02X3	6217	85BC02X3
500AT	6216	80BC02X3	6218	90BC02X3
5010AT	6218	90BC02X3	6222	110C02X3

* Motors sometimes have oversize ball bearing and roller bearing options

Brushes (Refer to Figs. 5, 6 and 7.)

Good brush performance is dependent on the care used in fitting and adjusting the brushes before the machines are put into service. An initial inspection of brush condition and

TABLE 14 MINIMUM BRUSH LENGTH (in inches)	
FRAME	MINIMUM BRUSH LENGTH*
CD180AT	.68
CD210AT-250AT	.70
CD280AT-320AT	.90
CD360AT	1.10
CD400AT	1.50
CD500AT	1.60
* Refer to Figs. 5, 6, 7 for drawing	

another inspection after the first two months of service is recommended to determine how often subsequent inspections are needed. Wear markers are provided on the brush pigtail. (Refer to **Figs. 6 and 7**) When the crimped marker approaches entry into the brush-holder, brush replacement should be investigated. For future ordering, record the brush part number which is stamped on the brush. (Refer to **Table 18**.)

CAUTION: DC motors and generators operated for long periods of time at light loads or in contaminated atmospheres may be subject to abnormal brush and commutator wear. This can result in the need for excessive maintenance and/or commutator damage. If the application requires operation under these conditions, GE Motors – DM&G – will be pleased to suggest a change in brush grade or other measures to minimize the problem.

WARNING: High voltage and rotating machinery can cause serious or fatal injury. Brushes may not be touched or replaced while the machine is energized or rotating.

CAUTION: The presence of silicone in DC motors, particularly totally enclosed constructions, will cause rapid brush wear. Sources of silicone include oils, RTV compounds, hand creams, mold release agents, grease, and some insulating varnishes. These silicone substances must be avoided to insure proper motor performance.



Fig. 5
Frame CD180AT

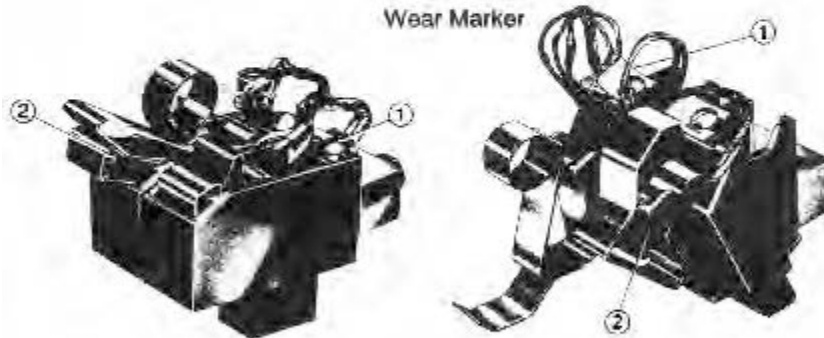


Fig. 6
Frames CD210AT-320AT

Fig. 7
Frames CD360AT-500AT

Measure Brush Length Here:

Fig. 5, 6, 7 Brushholder Assemblies

With Machines Stopped and Power Off:

(Refer to **Figs. 5, 6 and 7.**)

1. Unfasten pigtail (Refer to 1).
2. Release spring by pushing in slightly to disengage locking tab (Refer to 2), then pull spring back.
3. Remove brush.

Brush Installation:

1. Place brush in holder with bevel towards spring. Brushes should move freely in holder.
2. CD180AT – Release spring to original position against brush. CD210AT-CD500AT – Push spring into position until lock tab (Refer to 2) engages slot and locks.
3. Connect pigtail.

NOTE: If the brushholders have been disassembled, it may be necessary to readjust the height of the holder from the commutator surface. Loosen the brush stud to holder screw and adjust the holder until a gap of .070" to .080" is obtained. Re-tighten the screw and recheck the gap. (Refer to Fig. 8.)

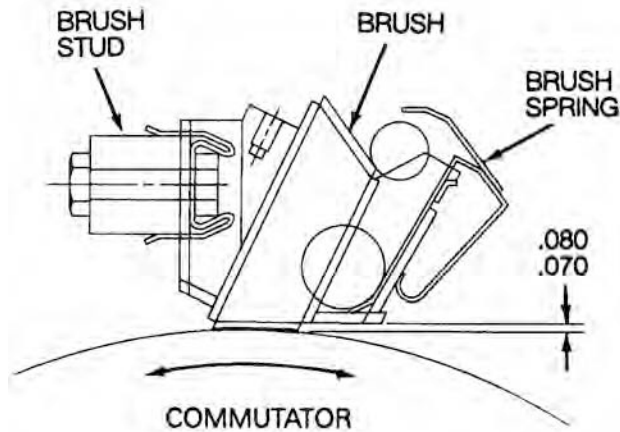


Fig. 8 **Correct Spacing of Brushholder to Commutator**

Brush Seating

Brushes should have their commutator contact surfaces curved to exactly fit the commutator surface. This is accomplished by "sanding in" the brushes in each brushholder separately. Draw a sheet of course non-metallic sandpaper (100-150 grit) under the brushes with the rough side toward the brush, while the brushes are pressed firmly toward the commutator. Do not use emery cloth. When sanding brushes, do not get carbon dust into the windings. The motor should be thoroughly blown out after sanding the brushes. This can be accomplished by cleaning the dust from the commutator, brushholders, and adjacent parts with a vacuum cleaner, air blast, or other suitable means. After the rough sanding, the brushes should be finely ground to fit using a brush seater. Rotate motors at around nameplate RPM. Make sure there is no load on the machine (armature current is nil). Carefully and lightly rub the brush seater across the entire commutator surface for 10 or 15 seconds. Repeat between each and every set of brush studs. Reverse motor rotation and repeat. Stop motor and cut all power to the motor and check brush face. Continue seating until brush face is 85% seated. Again, motor must be thoroughly blown out after brush seating, the same as with sanding.

CAUTION: Avoid inhaling carbon and seater dust. Recommend using a dust mask during sanding, seating and blowing, or vacuuming.

WARNING: High voltage and rotating parts can cause serious or fatal injury. The use of all electric machinery, like all other utilization of concentrated power and rotating equipment, can be hazardous. Installation, operation, and maintenance of electric machinery should be performed by qualified personnel. Familiarization with NEMA safety standards for construction and guide for selection, installation and use of integral HP motors and generator, National Electrical Code, and sound local practices is recommended.

CAUTION: Do not use liquid solvents of any kind. Solvents will not remove carbon dust accumulations, but will spread and wash them into critical areas.

Commutator

Keep the commutator clean. Ordinarily, the commutator will require only occasional wiping with a piece of canvas or other nonlinting cloth. **Do not use lubricant or solvent on the commutator.** Check the commutator for roughness while running by feeling the brushes with a fibre stick, avoiding contact with live electrical or moving mechanical parts. Jumping brushes give advance warning of deterioration of commutator surface. (Refer to the **Commutator Check Chart, GEA-7053** for commutator surface marking and causes of poor commutator condition.) Commutator runout over .003" T.I.R. (Total Indicator Reading) and bar to bar readings over .0003" indicate need for repair. (Refer to **Table 15**.)

CAUTION: The presence of silicone in DC motors, particularly totally enclosed constructions, will cause rapid brush wear. Sources of silicone include oils, RTV compounds, hand creams, mold release agents, grease, and some insulating var-nishes. These silicone substances must be avoided to insure proper motor performance.

TABLE 15
COMMUTATOR DIAMETERS (IN INCHES)

FRAME	NEW	MINIMUM
CD180AT	2.76	2.62
CD210AT	4.50	4.27
CD250AT	5.00	4.75
CD280AT	5.78	5.49
CD320AT	6.50	6.17
CD360AT	7.50	7.13
CD400AT	8.32	7.92
CD500AT	10.25	9.75

Commutator Undercutting Specifications

If the commutator is resurfaced, or during inspection or overhaul, insure the mica segments are undercut below the commutator surface. Commutator undercutting should be made to a depth of .040-.050". Following commutator resurfacing (stoning/turning), the segments should be "scarfed" by lightly breaking the sharp corners of the copper segments with a knife or tool made for that purpose. Scarfing segments will reduce carbon brush dust buildup and improve brush life.

Mechanical

Check the condition of air filters and replace them if they are dirty. Check for unusual noises which were not present when the unit was originally installed. Check all electrical connections for tightness. Clean out any dirt from screens, louvers, etc. which would interfere with flow of cooling air.

Shaft End Play

Standard endplay should be measured with a dial indicator. The limits are:

1. CD180AT thru CD320AT .005" to .040"
2. CD360AT thru CD500AT .000" to .015"

Some designs may use a wavy washer (preload spring) to eliminate endplay. The above limits do not include the axial endplay of the bearing itself which is approximately .002".

Waterproof Machines

Waterproof machines require the use of sealing de-vices to exclude water from the bearings and from entering openings in the magnet frame. When a waterproof machine has been disassembled, it will be necessary to remove the old sealing compound from around the mating surfaces of the bearing brackets and magnet frame; from underneath the field pole bolt heads and bearing cap to bearing bracket bolt heads; and from around the conduit box adapter threads to the magnet frame. Reapply new sealant (use Titeseal T20-66, light weight, GE part #905A999AC009) to these areas and wipe excess sealant with a clean rag slightly dampened with mineral spirits. When accessories such as brakes and tachometers are disassembled, it will be necessary to reseal at the accessory mounting face. Prior to reassembly, inspect for damage at gaskets around enclosure covers and at shaft rubbing seals located in the bearing caps.

Lubrication of Flexible Couplings

Flexible couplings are normally lubricated with a semi-fluid grease or an oil. The coupling manufacturer's instructions should be followed in choosing a lubricant and setting relubrication intervals. GE ball bearing grease D62A2C5 is a suitable lubricant for flexible couplings in most applications.

Flexible couplings which join a small machine to a large one may have two different size coupling halves joined by an adapter plate. Couplings of this type have a separate lubricant supply for each half, so that both halves must be lubricated separately.

Insulation

CAUTION: Eliminate sources of contamination and moisture for maximum insulation life. Air filters for blowers, air piped from cleaner locations, shielding from water leaks or spray, proper use of space heaters during downtime, etc., will all help prolong insulation life.

Premature failure of insulation is due to:

1. Contamination
2. Mechanical factors
3. High temperatures

Contamination includes excessive moisture, oily vapors, conducting and non-conducting dust, chips, and chemical fumes. Contamination is best avoided by proper enclosure and ventilation. Filters, ventilation from a remote clean air source, unit coolers, and a totally enclosed construction are all possible means of protecting DC machines in adverse environments. Space heaters protect against moisture damage by maintaining the machine above dew-point during storage or when idle. They should be arranged so that they are automatically energized whenever power is removed from the motor. Space heaters do not supply enough heat for drying out windings which have been water-soaked.

Mechanical factors include shock, vibration, overspeed, etc. Maintaining machines in good mechanical repair, including isolation from excessive external shock and maintenance of smooth running conditions, will contribute to long insulation life.

The insulation system in these machines is capable of withstanding some short time periods of operation at temperatures higher than that used for the basis of machine rating. Prolonged or excessively high temperature will cause the insulation to become brittle and crack, leading to premature failure. Application data is available from GE Motors-DM&G for any particular machine giving suggested maximum loads for various operating conditions. Operation within these maximum loads will limit the temperature to suitable values.

Testing Methods

Visual Inspection

Visual inspection is recommended as the quickest means of finding insulation systems troubles. Visual inspection may not sound like a test method, but a careful visual inspection done by a competent person is one of the most valuable means of judging insulation condition.

In addition to collecting contaminants, insulation shrinks, cracks, and becomes brittle with heat and age. These changes allow movement of coils, loose filter strips, loose ties, chafing, and abrasion, all of which can be picked up by visual inspection.

Experience and judgment can be gained by careful observation and comparing results of visual inspections with insulation resistance measurement. GE service shops have personnel who can inspect equipment and point out potential trouble areas. Their services can help build experience and judgment for future visual inspections.

Insulation Resistance Measurement

A method of measuring the insulation resistance is described in **Report 43, "Recommended Practice for Testing Insulation Resistance of Rotating Machinery"**, published by IEEE, 345 E. 47th Street, New York, NY 10017. The resistance measurements should be taken with a 500- or 1000-volt megger and corrected to 104°F (40°C).

The insulation resistance measurements are affected by the following:

1. Magnitude of test voltage.
2. Time and test voltage is applied.
3. Temperature.
4. Surface condition (contamination).
5. Moisture.

When a 1000-volt megger is used, taking readings of one minute and converting the data to 40°C (104°F), the data will evaluate the other two factors, i.e., the contaminants and the moisture present.

The insulation resistance varies inversely with the winding temperature. That is, as the temperature de-creases, the insulation resistance increases in ac-cordance with **Table 16**.

TABLE 16 EFFECT OF TEMPERATURE ON INSULATION RESISTANCE	
WINDING TEMPERATURE DEGREE C	MULTIPLYING FACTOR TO OBTAIN INSULATION RESISTANCE AT 40°C (104°F)
80	10.00
70	5.50
60	3.10
50	1.70
40	1.00
30	0.55
20	0.31
10	0.17

Note that for a 104°F (40°C) decrease in tempera-ture, the insulation resistance is increased by a multiplier of ten.

The insulation resistance of a machine if affected by its design. The insulation resistance of the armature circuit corrected to 104°F (40°C) should measure at least 1.5 megohms or cleaning is required.

If the measurements are less than this limit, the ma-chine should be dried or cleaned to attempt to in-crease the insulation resistance. Regular, periodic measurements of insulation resistance can give a useful indication of the rate of insulation system deterioration. External connections should be removed to isolate the windings to be tested and megger value logged. A sudden drop or consistent trend toward low values of insulation resistance, although possibly cause by moisture or contamination, generally gives evidence that the insulation system is deteriorating and that failure may be eminent.

High-potential tests are not recommended on machines which have been in use. If such a test is made immediately after installation, the test voltage should not exceed 85% of the original factory test of two times the rated voltage plus 1000 volts.

NOTE: Surge testing and AC impedance tests of windings to detect shorts should be performed only by trained personnel.

Cleaning of Windings

If windings become contaminated, suitable cleaning methods can be used to alleviate the problem

The machine should be de-energized and slowly rotated by hand to permit maximum dust removal. Dry dirt, dust, or carbon should first be vacuumed – without disturbing adjacent areas or redistributing the contamination. Use a small nozzle or tube connected to the vacuum cleaner to enter into narrow openings (i.e., between commutator risers). A soft brush on the vacuum nozzle will loosen and allow removal of dirt ore firmly attached.

This vacuum cleaning may be supplemented by blowing with compressed air (air pressure should be in accordance with OSHA standards), which has passed through a dryer to remove moisture before entering the motor.

Dirt can collect on the inside surface of the drive-end coil support and on the underside of the armature coils. This dirt can be easily removed with compressed air or a vacuum. Dirt may also accumulate in the axial vent holes which pass all the way through the armature core and commutator. It usually will be necessary to use compressed air to blow this dirt out. The commutator vent holes can best be cleaned by directing air from the commutator end.

It is important to realize that when blowing out a machine, dirt may settle in a previously cleaned areas and it may be necessary to repeat the cleaning process to ensure that a thorough job is done.

Dirt can be removed from stationary parts of the machine by either compressed air or a vacuum nozzle or a combination of both. Air should be directed between the stator coils, into the pocket corners of bearing brackets, around the cables, and onto the brush rigging. Special care should be taken to keep the commutator clean. The commutator should be wiped with a clean lint-free cloth after blowing out.

WARNING: High volume electric shock can cause serious or fatal injury. Electrical circuits must be de-energized prior to cleaning or other maintenance activities. Ground electrical circuits prior to cleaning or maintenance to discharge capacitors. Failure to observe these precautions may result in injury to personnel.

CAUTION: Liquid solvents should not be directly applied to the commutator, armature, field coils, or any part of a DC machine. Liquid solvents carry conducting contaminants (metal dust, carbon, etc.) deep into hidden areas to produce shorts and grounds, thus causing machine failure. Mechanical components may be cleaned by a wiping rag barely moistened (not wet) with a solvent.

WARNING: Solvents may be flammable and moderately toxic. The usual precautions for handling chemicals of this type must be observed. These include:

1. Avoid excessive contact with skin.
2. Use in well-ventilated areas.
3. Take necessary precautions to prevent fire or explosion hazards.

WARNING: Safety glasses and/or other protective equipment should be used to prevent injury to eyes and respiratory organs.

Oily Dirt

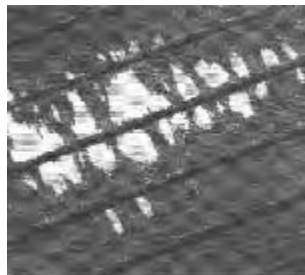
The presence of oil makes thorough, effective cleaning of machines in service virtually impossible and service shop conditioning is recommended. Oil on a surface forms a "fly paper effect", which attracts and holds firmly any entrained dust. Neither suction nor compressed air is effective. Consequently, only accessible areas may be cleaned. First, remove as much of the dirt as possible by scraping or brushing the dirty surfaces. Then, wipe away as much dirt as possible with dry rags. For surfaces not readily accessible, a rag on a hook wire can be used to clean dirt out of holes and crevices. Rags should be changed frequently for clean ones so that contamination picked up from one area is not carried to other less dirty areas.

To simplify removal of oily dirt, solvents are commonly prescribed.

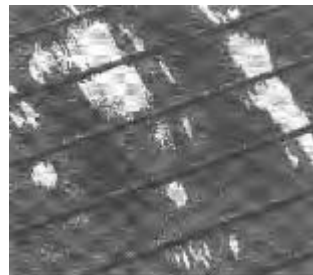


Commutator Check Chart For Comparing Commutator Surface Markings

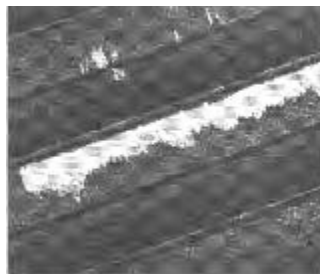
SATISFACTORY COMMUTATOR SURFACES



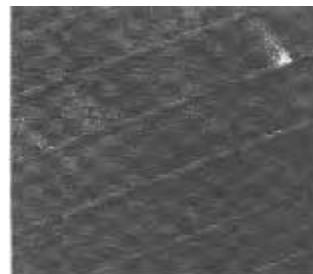
LIGHT TAN FILM over entire commutator surface is one of many normal conditions often seen on a well-functioning machine.



MOTTLED SURFACE with random film pattern is probably the most frequently observed condition of commutators in industry.

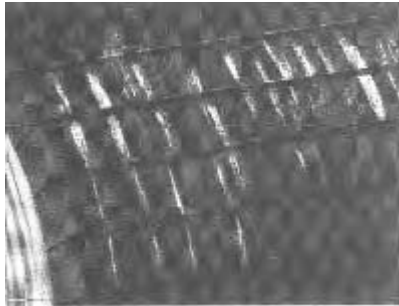


SLOT BAR-MARKING, a slightly darker film, appears in a definite pattern related to number of conductors per slot.

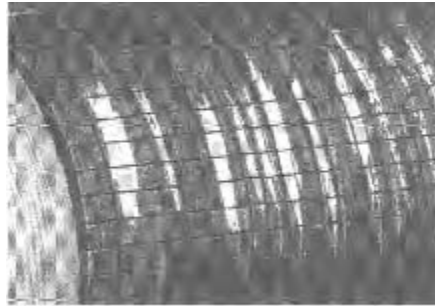


HEAVY FILM can appear over entire area of efficient and normal commutator and, if uniform, is quite acceptable.

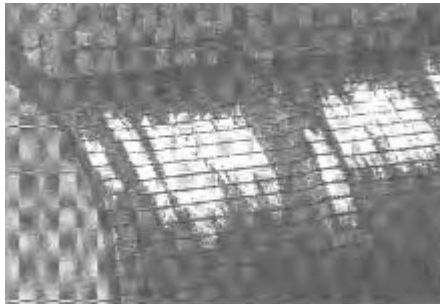
WATCH FOR THESE DANGER SIGNS



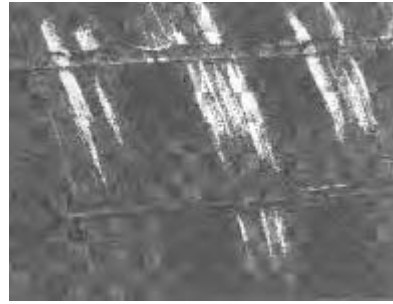
STREAKING STREAKING on the commutator surface signals the beginning of serious metal transfer to the carbon brush. Check the chart below for possible causes.



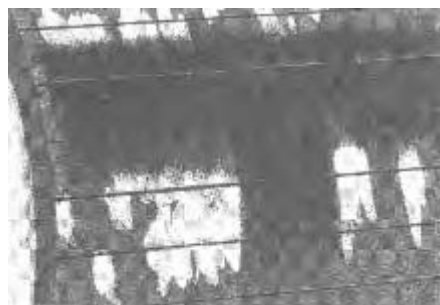
THREADING THREADING of commutator with fine lines results when excessive metal transfer occurs. It usually leads to resurfacing of commutator and rapid brush wear.



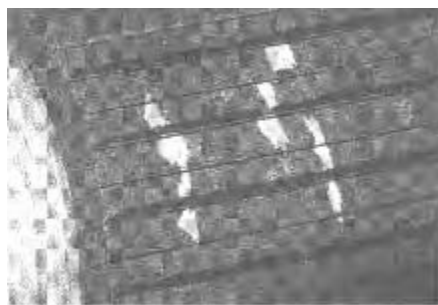
GROOVING GROOVING is a mechanical condition caused by abrasive material in the brush or atmosphere. If grooves form, start corrective action.



COPPER DRAG, COPPER DRAG, an abnormal build-up of commutator material, forms most often at trailing edge of bar. Condition is rare, but can cause flashover if not checked.



PITCH BAR-MARKING PITCH BAR-MARKING produces low or burned spots on the commutator surface. The number of these markings equals half or all the number of poles on the motor.



HEAVY SLOT BAR-MARKING HEAVY SLOT BAR-MARKING can involve etching of trailing edge of commutator bar. Pattern is related to number of conductors per slot.

CAUSES OF POOR COMMUTATOR CONDITION

Frequent visual inspection of commutator surfaces can warn you when any of the above conditions are developing so that you can take early corrective action. The chart below may indicate some possible causes of these conditions, suggesting the proper productive maintenance.

	Electrical Adjustment	Electrical Overload	Light Electrical Load	Armature Connection	Unbalanced Shunt Field	Brush Pressure (light)	Vibration	Type of Brush In Use		Contamination	
								Abrasive Brush	Porous Brush	Gas	Abrasive Duty
Streaking			X			X		X	X	X	x
Threading			x			X			X	X	
Grooving								X			X
Copper Drag						X	X	X		X	
Pitch Bar-Marking				X	X	X	X	X			
Slot Bar-Marking	X	X								x	
GE Motors 3001 East Lake Road Erie, PA 16531 Phone: 814-875-3129 FAX: 814-875-3421 GEA-7053A		HOW TO GET THE MOST VALUE FROM THIS CHART The purpose of the Commutator Check Chart is to help you spot undesirable commutator conditions as they develop so you can take corrective action before the condition becomes serious. This chart will also serve as an aid in recognizing satisfactory surfaces. The box chart above indicates the importance of selecting the correct brush and having the right operating conditions for optimum brush life and commutator wear. For additional information or help with carbon brush application or commutation problems, contact your nearest GE Sales Office or Distributor. © 1992 General Electric Company 1/92 (30M) M/GCO Printed in U.S.A.									

WARNING: While FREONTF® is considered to be non-flammable and has a relatively low order of toxicity, it should be used only in well-ventilated areas that are free from open flames. Avoid prolonged exposure to vapors. Failure to observe these precautions may result in injury to personnel

FREON TF is the recommended solvent for cleaning because it is nonflammable, has good solvency for grease and oil, is considered safe with most varnishes and insulations, and has a low order of toxicity. Stoddard Solvent has good solvency, but is flammable and moderately toxic. Before using an solvent, consult the Material Safety Data Sheet. Steam cleaning is not recommended because, as with liquid solvents, conducting contaminants may be carried deep into inaccessible areas resulting in shorts and grounds.

FREON TF is a chlorofluorocarbon. Chlorofluorocarbons have been identified as upper atmosphere ozone depleters. The use of Freon in industry is expected to be greatly reduced in the future. The availability of Freon may be limited, and its use could be prohibited by regulations.

CAUTION: Carbon brush performance may be ruined by absorbed solvents. Remove brushes prior to solvent wiping.

Drying of Windings

Drying of machines is most effectively done by application of heat. The windings and insulation should be heated so that their temperature does not exceed 225°F (125°C) at any location. (Do not make local hot spots.) The machine's own frame and the addition of some covers usually will make an effective enclosure to contain the heat, if an oven cannot be used. Some flow of air is desirable to allow moisture to be carried away. Methods of generating heat include blowing hot air through the machine, heating with heat lamps, passing current through the main-field-coil windings, etc.

If temperatures as high as 225°F (125°C) can be attained, they should be limited to six or eight hours duration. Lower temperatures will cause correspondingly longer drying times.

® Registered trademark of the E.I. DuPont Co.

Drying out can be ended when the insulation resistance to ground (corrected to 40°C) is restored to a satisfactory value as described in the **Insulation Resistance** section. If these values do not reach a proper level, then a thorough cleaning or complete reconditioning may be necessary.

Service Shop Cleaning

When the cleaning or drying methods described in preceding paragraphs do not result in restoration of acceptable insulation resistance and/or when machines are extremely dirty or contaminated, it is recommended that the reconditioning services of a GE service shop be obtained. Service shops are knowledgeable and equipped for more sophisticated restoration methods, such as hot water detergent wash, solvent and abrasive cleaning, revarnishing, and rewinding if necessary.

Repair

Repairs should be made only by qualified personnel using the materials and processes for which the motor was designed. To protect the warranty during the warranty period, all repairs must be made in a GE service shop or approved repair facility. Many repairs can be easily performed with only assembly operations, if GE replacement parts are available. If major repairs are undertaken (such as rewinding an armature), proper facilities should be available and suitable precautions observed.

WARNING: When burning off old insulation materials or when welding near insulation during rewinding, adequate ventilation must be provided to avoid exposing personnel to noxious fumes. Combustion of exhaust fumes must be complete and adequately vented to the outside atmosphere.

WARNING: Exposure of personnel to airborne inorganic fibers must be avoided by adequate ventilation or by wetting the remaining insulation components following the burning off of the organic materials.

Failure

WARNING: An extreme overload or electrical failure may result in heating or arcing, which can cause the insulation to give off noxious fumes. All power should be removed from the motor circuit as a pre-caution, even though the circuit has overload protection. Personnel should not approach the motor until adequate ventilation of the area has purged the air of fumes. When covers of a totally enclosed motor are removed after a failure, care should be observed to avoid breathing fumes from inside the motor. Preferably, time should be allowed for the motor to cool before attempting any examination or repair.

WARNING: Water should not be applied to any electrically energized equipment because electric shock could result in serious or fatal injury. In case of fire, disconnect all power and use a carbon dioxide extinguisher to quench the flame.

Before operating any motor after a suspected failure, it should be inspected for damage. Remove covers and make visual inspections of the brushes, commutator, connections, and windings. Electrical tests of each winding to check for open or short circuit or grounds should be made. Any arc damage should be cleaned up and repaired as necessary. Brushes may need re-seating before operation.

RENEWAL PARTS

Using genuine GE renewal parts assures continued high performance and the full benefits of the long operating life designed into your GE motor.

Downtime can be minimized by having a protective stock of parts available for replacement. (Refer to **Table 17.**)

The permanently attached nameplate on your GE motor displays the model and serial number, providing all the information you need for ordering. Parts are available directly from authorized GE-DM&G parts distributors. Direct electronic access to the factory database of motor information and warehouse inventories enables the distributor to quickly identify part numbers, delivery times, and order status.

**Distributor location is available to you at (814) 875-2387
(and toll free outside Pennsylvania at 1-800-458-0451).**

For your convenience, **Table 18** outlines standard brush and brush spring part numbers to assist in ordering renewal parts.

SPARE PARTS

TABLE 17 RECOMMENDED SPARE PARTS					
As insurance against costly downtime, it is strongly recommended that spare parts be kept on hand in accordance with the chart below:					
DESCRIPTION	NUMBER OF DUPLICATE MOTORS IN SERVICE				
	1	2 – 4	5 – 10	11 – 20	More than 20
WITH OR WITHOUT ELECTRICAL SHOP FACILITIES					
Complete Machine	-	-	-	1	2
Drive End Ball Bearing	1	1	1	2	3
Front End Ball Bearing	1	1	1	2	3
Brushes (Sets)	2	4	6	8	10
Brushholders (Sets)	-	½	½	1	1
Brushholder Springs (Sets)	½	1	1	2	2
Main Field Coil and Pole	-	1	1	2	3
Commutating Field Coil and Pole	-	1	1	2	3
Armature Complete*	-	1	1	2	2
Blower Vent, motors	-	1	1	2	2
Blower motors	-	1	1	2	2
WITH ELECTRICAL SHOP FACILITIES					
Shaft**	-	-	-	1	1
Armature Rewinding Supplies	-	1	1	2	3
*If shop facilities are available, the quantity of armatures may be reduced by stocking the armature parts listed in the second group. **Shaft not replaceable in CD180AT thru CD250AT.					

TABLE 18
STANDARD BRUSH AND BRUSH SPRING PART NUMBERS

FRAME SIZE	STANDARD BRUSH PART NUMBER*	BRUSH SPRING PART NUMBER
CD180AT	36A167400AA001	36B467022AB001
CD210AT	36A167401AA008	36B467020AA001
CD250AT	36A167401AA008	36B467020AA001
CD280AT	36A167402AA004	36B467021AA001
CD320AT	36A167402AA004	36B467021AA001
CD360AT	36A164456AA021	36B465486AA001
CD400AT	36A164451AB018	36B465481AD001
CD500AT	36A164452AA021	36B465482AA001

* Brush part numbers are for most applications. Special applications such as papermills, pump motors, diesel-driven generators and others may require special brush grades. Before ordering brushes, check the part number stamped on the brush to ensure the correct brush replacement.

<u>Name</u>	<u>Qty.</u> <u>Per Motor</u>
1. Brush	2
2. Brush Spring	2
3. Bearing C.E.	1
4. Bearing D.E.	1
5. Armature	1
6. Coil & Pole Comm.	2
7. Coil Main	2
8. Bearing Bracket (CE)	1
9. Access Cover	1
10. Brush Rigging	1
11. Armature Fan	1
12. Bearing Bracket (DE)	1
13. Wound Frame Assembly	1

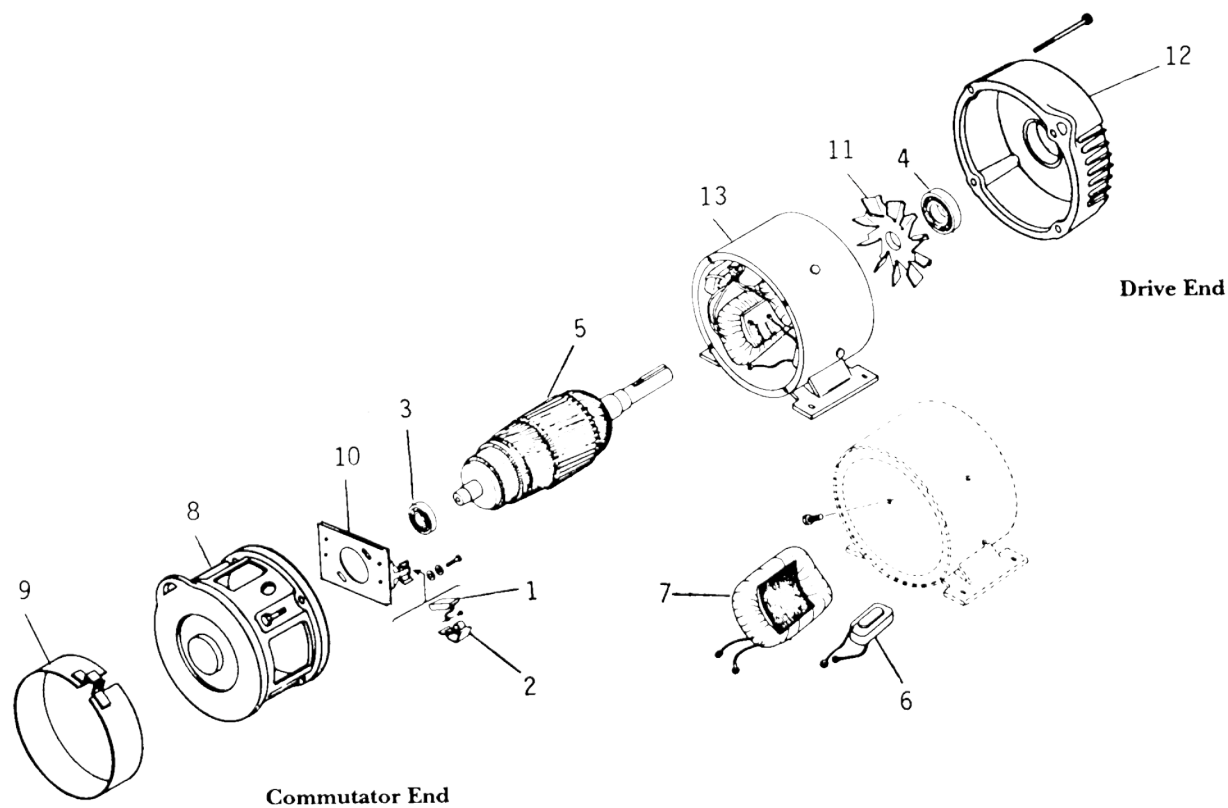
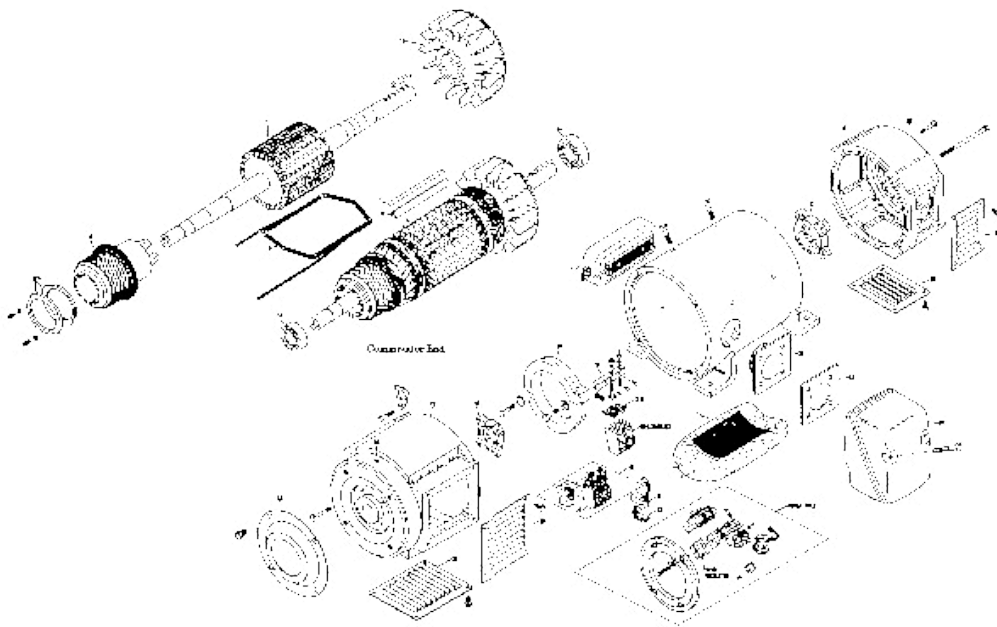


Fig. 9 CD180AT Frame, Exploded View

<u>Ref. No.</u>	<u>Description</u>
1.	Main Coil and Pole Assembly
3.	Comm. Coil and Pole Assembly
4.	Armature
5.	Armature Coil
7.	Slot Wedge (Through CD400AT)
8.	Slot Insulation (Through CD400AT)
11.	Armature Shaft and Core Assembly
12.	Commutator
12A.	Balance Rings (Used on CD180AT-CD320AT)
* 13.	Bearing Bracket
* 14.	Ball Bearing
* 15.	Bearing Cap
17.	Armature Fan



- 18. Brush Rigging (Includes Complete Assembly for CD180AT)
- 20. Brushholder Yoke
- 21. Brushholder Stud (Includes Insulator on CD500AT)
- 22. Brushholder (With Pressure Spring and Clip, if needed)
- 23. Brushholder Spring
- 24. Carbon Brush
- 26. Conduit Box
- 29. Conduit Box Adaptor
- 30. Bearing Bracket Covers (Specify side, bottom or top)
- 32. Shaft Cover
- 34. Conduit Box Gasket
- 38. Bearing Retaining Ring (Used on CD360AT-CD500AT Drive End Only)

*Specify whether for drive end or commutator end.

Fig. 10 CD210AT – CD500AT Frames, Exploded View



LUBRICATION

Typically, routine maintenance should include lubrication, cleaning, testing, and moisture prevention. To be effective, however, each of these operations must be performed with care.

Lubrication is a good-example. A fact that is surprising to many is that too much lubrication is a major cause of premature motor failure. When too much grease is applied, it is eventually forced out of the bearing housings and begins dripping on the motor windings. The grease then attacks and destroys the insulation, resulting in early motor failure.

When it comes to lubrication, most motors require only one shot of grease each year. But before lubricating a motor, care should be taken to remove the drain plug. Once the new grease has been added, the motor should be allowed to run for 10 minutes before replacing the drain plug. This insures that excess grease will be disposed of without damaging the windings.

LUBRICATION FREQUENCY & VOLUME GUIDE

1. Sleeve Bearing Motors

- Re-oil **annually** after the second year of service to extend life for normal duty.
- Re-oil **more frequently** for continuous or severe duty operation.
- Re-oil **every two years** for light intermittent duty and at least every five years for light occasional duty.
- Add up to 30 drops of **electric motor oil** or an SE grade of SAE 10 motor oil to each bearing when re-oiling. (Small Motors)

Type of Enclosure	Insulation	-- Frame Size --		
		143 to 215T	254 to 325T	364 to 449T
Open - DP	B	2 yrs.	18 mo.	1 yr.
Enclosed - FC	B	2 yrs.	18 mo.	1 yr.
Open - DP	F	18 mo.	1 yr.	9 mo.
Enclosed - NV	B	18 mo.	1 yr.	9 mo.
Enclosed - FC	F	18 mo.	1 yr.	9 mo.

2. Permanently lubricated ball bearing motors are factory lubricated and under normal operating conditions will require **no** additional lubrication for ten years.

Regreasable ball or roller bearings as furnished are adequate for a long period of operation without relubrication. A good maintenance schedule for regreasing will vary widely depending on motor size, speed, duty and environment.

3. Procedure for Relubrication

When regreasing, stop motor, remove inlet and outlet plugs, and add amount of grease per reference table with hand lever gun only, **Do not expect grease to appear at the outlet, but if it does, discontinue greasing at once.** Run for about ten minutes before replacing outlet plug. Certain TEFC motors have a spring relief outlet fitting on the fan end; if the outlet plug is not accessible at surface of hood, it is the spring relief type and need not be removed when regreasing.

4. Frequency of Relubrication The following table suggests relubrication intervals for motors on normal, steady running, light duty indoor loads in relatively clean atmosphere at 40°C (104°F) ambient temperature or less:

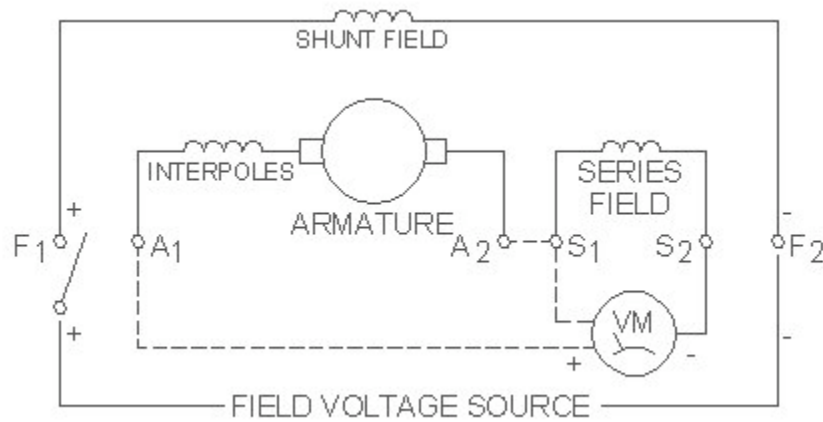
Open - DP	H	1 yr.	9 mo.	6 mo.
Enclosed - Lint Free - FC	B	1 yr.	9 mo.	6 mo.
Enclosed - NV	F	1 yr.	9 mo.	6 mo.
Enclosed - FC	H	9 mo.	6 mo.	3 mo.
Enclosed - Lint Free - FC	F	9 mo.	6mo.	3 mo.

NOTE: FOR MOTORS OVER 1800 RPM - Use 1/2 of tabled period.
 FOR SEVERE DUTY
 DUSTY LOCATIONS
 HIGH AMBIENT - Use 1/3 of tabled period.

Volume-Reference Table

Shaft Diameter (At Face of Bracket)	Amount of Grease to Add
3/4" to 1-1/4"	1/8 cu. in. or 0.1 oz.
1-1/4" to 1-7/8"	1/4 cu. in. or 0.2 oz.
1-7/8" to 2-3/8"	3/4 cu. in. or 0.6 oz.
2-3/8" to 3-3/8"	2 cu. in. or 1.6 oz.

CAUTION: Over greasing is a major cause of bearing and motor failure. Make sure dirt and contaminants are not introduced when adding grease.



**A METHOD OF TESTING TO DETERMINE
IF SERIES FIELDS ARE PROPERLY
CONNECTED IN EITHER A COMPOUND
OR STABILIZED SHUNT DC MOTOR.**

Connect a low range DC voltmeter across either the series winding or across both series and armature circuit for the same polarity as operating source. At the time the shunt field is being energized, the voltmeter should read positive during the build up of shunt field, and meter will reverse as field is open or collapsed.

This method is very easy to use in shop or field - reliable and safe, but depends on strict observance of polarities.

To correct improper readings, reverse S1 and S2 leads.

F

FAILURES IN THREE-PHASE STATOR WINDINGS



The life of a three-phase stator winding can be shortened dramatically when the motor is exposed to unfavorable operating conditions - electrical, mechanical or environmental. The winding failures illustrated in this section are typical of what can happen in such circumstances. They are shown here to help in identifying the causes of failure, so that, where possible, preventive measures may be taken.

A new stator winding is pictured to the right for purposes of comparison with the winding failures shown in Photos 1 - 12. Descriptions of the causes of failure are provided.



Engineering Committee
Electrical Apparatus Service Association, Inc.
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St. Louis, Missouri 63132
(314) 993-2220

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585 OP 25M

FAILURES IN THREE-PHASE STATOR WINDINGS



1

**Winding Single-Phase
(Y - Connected)**



2

**Winding Single-Phased
(Delta - Connected)**

TYPICAL CAUSES OF WINDING FAILURES IN THREE-PHASE-STATORS

A single-phase winding failure is the result of an open in one phase of the power supply to the motor. The open is usually caused by a blown fuse, an open contactor, a broken power line or bad connections.

FAILURES IN THREE-PHASE STATOR WINDINGS



3

**Winding Shorted
Phase-To-Phase**



4

**Winding Shorted
Turn-To-Turn**



5

Winding with Shorted Coil



8

Shorted Connection

TYPICAL CAUSES OF WINDING FAILURES IN THREE-PHASE-STATORS

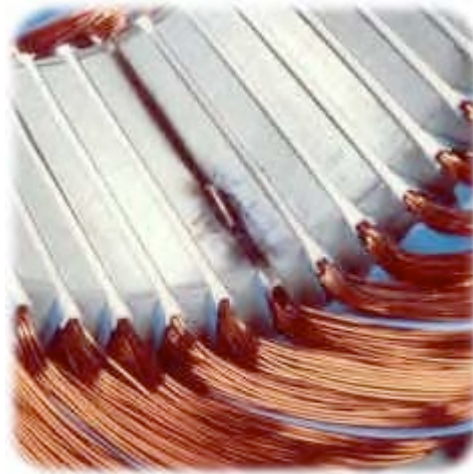
These photos illustrate insulation failures that typically are caused by contaminants, abrasion, vibration or voltage surge.

FAILURES IN THREE-PHASE STATOR WINDINGS



6

**Winding Grounded
at Edge of Slot**



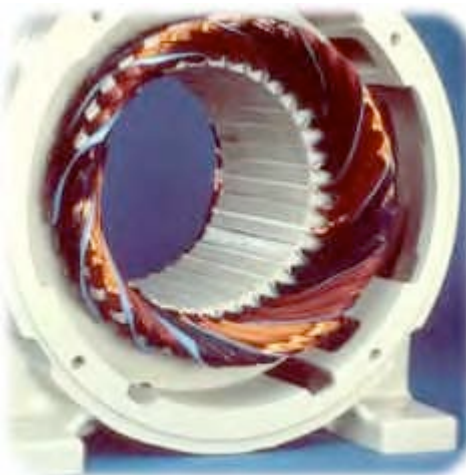
7

**Winding Grounded
in the Slot**

TYPICAL CAUSES OF WINDING FAILURES IN THREE-PHASE-STATORS

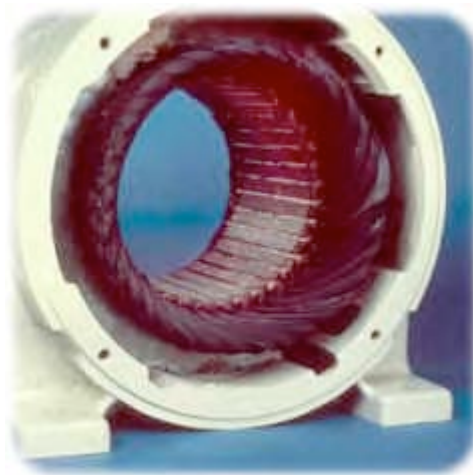
These photos illustrate insulation failures that typically are caused by contaminants, abrasion, vibration or voltage surge.

FAILURES IN THREE-PHASE STATOR WINDINGS



9

**Phase Damage Due to
Unbalanced Voltage**



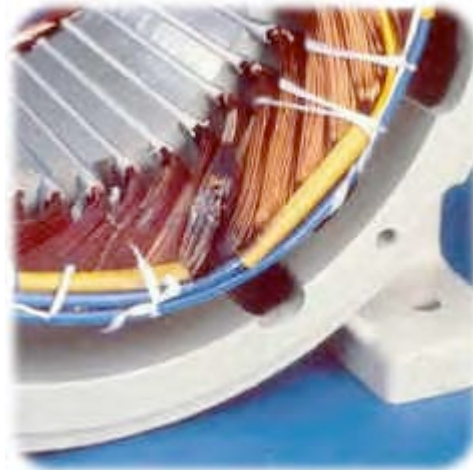
10

**Winding Damaged
Due to Overload**



11

**Damage Caused
by Locked Rotor**



12

**Winding Damaged
by Voltage Surge**

TYPICAL CAUSES OF WINDING FAILURES IN THREE-PHASE-STATORS

9. Thermal deterioration of insulation in one phase of the stator winding can result from unequal voltage between phases. Unequal voltages usually are caused by unbalanced loads on the power source, a poor connection at the motor terminal, or a high resistance contact (weak spring).
NOTE: A one-percent voltage unbalance may result in a six-to ten-percent current unbalance.
10. Thermal deterioration of the insulation in all phases of the stator winding typically is caused by load demands exceeding the rating of the motor.
NOTE: Under-voltage and over-voltage (exceeding NEMA standards) will result in the same type of insulation deterioration.
11. Severe thermal deterioration of the insulation in all phases of the motor normally is caused by very high currents in the stator winding due to a locked rotor condition. It may also occur as a result of excessive starts or reversals.
12. Insulation failures like this usually are caused by voltage surges. Voltage surges are often the result of switching power circuits, lightning strikes, capacitor discharges and solid-state power devices.


Rotor Construction

Compare for
Yourself

Copper

VS

Aluminum



Copper

For over a century, Westinghouse motors have been synonymous with quality and reliability. Over time, product enhancements have been continually refined, resulting in dependable, long-term performance year after year.

Today, as always, all large Westinghouse Motor Company Induction motors greater than 250 HP feature copper or copper alloy rotor bars and end rings.

Some of our competitors will try to persuade you to save a few dollars and settle for aluminum rotors on their large machines. We believe you cannot afford to operate without copper rotor construction. Please read on and decide for yourself.

The real test for rotor material is during starting because this is when the motor is subjected to extreme operating conditions. During this period, large AC motors can be rotor limited. This means that the rotor cage will reach its thermal limit before the stator winding.

In this demanding period of operation, copper offers a significantly higher range of resistivity and a much higher thermal margin.

Copper also provides a lower coefficient of expansion, higher tensile strength, and ideal conductivity.

Without a doubt, Westinghouse Motor Company's copper rotor construction gives you greater reliability, efficiency, and versatility with which aluminum cannot compare.

Aluminum

Cast aluminum rotors appeared years ago on small motors and are now accepted as the industry standard for those machines.

Today, many motor manufacturers have switched to fabricated aluminum rotors in their large motors, presumably because of the lower cost of aluminum.

In fact, most of our competitors have standardized on aluminum rotors.

Aluminum rotors have many limitations compared with copper. For example, an aluminum die cast rotor cannot be repaired. And aluminum fabricated rotors only can be repaired with great difficulty.

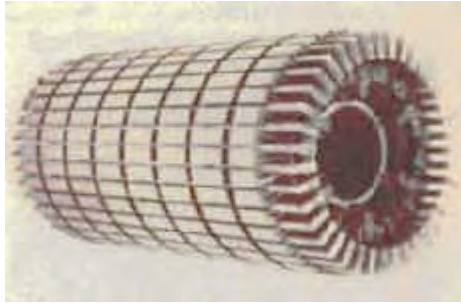
The Westinghouse Motor Company uses only copper on large AC machines because our experience leads us to believe that aluminum rotors are more likely to fail.

These damaged aluminum rotor bars were removed from competitors' failed motors. Note the severe deformity and degradation.

Copper

Lower Coefficient of Expansion

Aluminum will creep and move approximately 33% more than copper. This large movement will eventually lead to fatigue failure in rotor material due to thermal expansion and contraction.



WMC's copper rotor design ensures higher reliability compared to aluminum bars.

Tensile Strength

Copper is 300% stronger than aluminum and thus able to withstand high centrifugal force and repeated hammering of the current-induced forces during each start.

Higher Melting Point

Copper can better withstand thermal cycling over the life of the motor.

Conservative Temperature Rise

Copper features conservative temperature rise limitations which prevent excessive deterioration in mechanical properties.

Improved Joint Design

Westinghouse Motor Company's improved bar to end ring joint design minimizes stresses and stress concentrations.

Aluminum

Limited Range of Resistivity

A far greater range of resistivity is available on copper alloys than with aluminum and aluminum alloys. As a result, performance may have to be compromised if aluminum is used.

Fatigue Sensitivity

Many tests indicate that aluminum is more susceptible to fatigue than copper or copper alloy.

High Temperature Rise

Aluminum has a 35% higher temperature rise than copper for the same KW loss.

Adverse Effect of Temperature on Mechanical Properties

The physical properties of heat-tested aluminum will decrease even at temperatures as low as 150° C. Temperature rises on bars much higher than this are not unusual during starting and acceleration.

Poor Joint Design

Welded Aluminum joints, with attendant stress concentration, residual thermal stresses, and reduction in physical properties, can result in failure.

Laminations Become Loose

Through repetitive thermal cycling, aluminum laminations can become loose, resulting in early failure.

Rotor Design

A key to the reliability of Westinghouse Motor Company motors is our emphasis on superior rotor design.

Rotor cores are held together by sturdy end plates and rugged thru-bolt construction or other clamping methods.

In addition to our proven copper construction, our large AC rotors are precision-crafted with the following time-tested design features:

Swaging

Swaged rotor bars ensure long life by minimizing the movement and vibration that can cause bar fatigue and failure.

High Frequency Induction Brazing

End rings are joined to the bars by high frequency induction brazing on most rotors. This reduces stresses and hot spots in the joint.

Keeper Blocks

These ensure increased rotor integrity by preventing cage migration from end to end.

Repair Considerations

Our experience leads us to believe that aluminum rotor designs are more likely to fail and are more difficult to repair compared with copper.

The primary causes for most rotor failures are loose rotor bars and poor bar to end ring welds.

By now you already understand how copper's inherent advantages -lower coefficients of expansion, higher tensile strength, and improved joint design -make it a superior material.

The Westinghouse Motor Company's practice of swaging, high frequency induction brazing, and thru-bolt construction further ensure long-term reliability.

In the unlikely event that a copper rotor does fail, it is significantly easier to repair than aluminum. Copper's usual rectangular design makes it easy for repair shops to rework bars and laminations.

Aluminum bars, on the other hand, are built in a wider variety of shapes with correspondingly designed slots in the rotor laminations.

We believe that the resulting lamination slot design often makes aluminum rotors either difficult or impossible to repair.

Don't be misled by aluminum's lower initial selling price. Because of the risk of failure, aluminum may cost you a lot more in the long run.

Customer Focus

The Westinghouse Motor Company designs, manufactures, and sells Induction, Synchronous, and DC motors and generators to customers throughout the world.

As our customer, you have access to exceptional service. Engineering support, computer studies, product information, quotation assistance, and professional order management are top priorities.

Also, you can rely on our worldwide field service and engineering network to service and protect your investment.

For more information about the Westinghouse Motor Company's dependable copper rotor construction or any of our outstanding world-class products, contact your local Westinghouse salesperson or call us at our Round Rock, Texas, headquarters at 1-800- 451-8798.

the Inspection and Maintenance

DRILLING MOTOR/GENERATOR TYPE JEC 75Z

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WARNING: When the JEC 75Z motors and generators are pinned (auxiliary switch activated), be alert to the fact that AC voltage is still present on the device terminal boards since:

1. Space heater is still on (240 VAC).
2. Blower unit is still on unless it is independently switched off (460 VAC).

Failure to observe this warning could result in severe electrical shock.

A. DATA

Max. Permissible Speed (RPM)

Motors..... 1800
Generators..... 1200
Max. Permissible Vibration (In.), Comm. End... 0.002

Carbon Brushes

Type..... Duplex with Rubber Pad
Size (In.)..... $\frac{3}{4} \times 2\frac{1}{4} \times 2$
Minimum Brush Length (Length at which
Brush becomes inoperative (In.)..... $1\text{-}\frac{3}{32}$
Spring Pressure on Brush, Preset (Lb.)..... 10-12

Brushholder

Clearance to Commutator (In.)..... $1/16\text{-}3/32$
Clamp Bolt Torque (Lb. Ft.)..... 225-250

Commutator

Side Mica Thickness (In.)..... 0.060
Slot Depth (In.)..... 0.047

Undercutting Saw: - Width..... 0.063
 - Diameter..... 1.000
Diameter: - New..... 16.625
 - Worn (Minimum Permissible)..... 15.375
Riser Width (Minimum Permissible)..... 0.625
Dust Groove: - Width..... 0.250
 - Depth..... 0.125

Concentricity – Used Commutator

Resurface if runout exceeds 0.010 TIR or 0.003 within any group of 6 bars):
After Resurfacing, TIR (In.)..... 0.001

Bar-To-Bar Test (500 V)

Voltage Variation Bar-To-Bar..... $\pm 5\%$

Lubrication

Armature Bearings (oz.)

Grease Capacity

Drive End..... 39

Double Shaft Commutator End..... 31

Single Shaft Commutator End..... 12

High-Potential Test

(60 Hz., AC, to Ground for 1 Minute)

All Windings (Volts)

Reconditioned..... 2000

CAUTION: *This machine is of open-splash-proof construction. It is force-ventilated by a fan and requires an ample supply of cooling air. The cooling air should not contain combustible gases. If it is applied in an environment which may contain combustible gases, an adequate supply of non-contaminated cooling air must be provided.*

B. LUBRICATION

The frequency of lubrication will depend, to a considerable extent, on the severity of service of the machine. However, we suggest for normal operation that a basic overhaul of the machine be performed every three years or 18,000 hours.

C. INSPECTION

1. MONTHLY

Inspect exterior of machine, including cables for damage.

Covers, Seals, Latches

Clean the outside of the machine and remove the inspection covers. Use clean, dry compressed air (at 29 psi Maximum Pressure) and blow the dirt and carbon dust from the interior of the machine.

WARNING: *Personal injury may result if proper eye protection is not worn when cleaning with compressed air.*

Check exterior covers to be sure felt seals are intact. If seals are missing or covers are damaged, replace seals or covers as necessary. Make sure covers fit properly and cover latches work properly.

Brushholders

Inspect the brushholders for damage. If brushholder(s) will be replaced, refer to BASIC REPAIRS, Brushholder Replacement section for instructions.

Brushholder Sleeves

Use a clean lintless cloth and wipe dirt and grease from the Teflon brushholders sleeves. If necessary, use a cleaner such as MEK (methyl ethyl ketone) to clean the sleeves. Inspect sleeves for cracks and thin spots caused by flashovers. Replace any damaged brushholder or one having a damaged sleeve.

WARNING: *MEK is a volatile solvent. The fumes should not be inhaled. Use only in a well-ventilated area and take adequate precautions to protect eyes skin and hands.*

Note: Never paint these sleeves. Periodically wipe them clean with a dry cloth or a cloth dipped in an approved non-oily cleaning solvent.

Inspect the brushholder cables and make sure all terminal bolts and all brushholder clamp bolts are tight.

Brush Spring Pressure

Lift the brush pressure fingers to the "toggled-up" position and check for free movement of spring assembly.

Inspect brush springs for obvious failure or damage. Check brush-spring pressure by comparing spring pressure with a spring known to be good. Refer to DATA section for brush spring-pressure value.

Brushes

Brush wear is determined by measuring actual brush length from the top of the carbon. Lift the brush spring, remove the brush and measure brush length.

Note: Be sure that used brushes are of sufficient length to last until the next inspection.

If brush is worn to or near the minimum length listed in DATA section, replace all brushes.

WARNING: *To avoid possible electric shock or injury from rotating equipment. Do not remove or replace brushes while equipment is energized or rotating.*

If brushes will be replaced, see BASIC REPAIRS, Brush Replacement section for instructions to install new brushes.

CAUTION: *When replacing brushes, use the recommended grade. Mixing of brush grades in the same motor or changing brushes to another grade is not recommended as this will seriously affect commutation, surface film, commutator and brush life.*

If brushes will NOT be replaced, the following brush inspection should be made:

- a. Inspect all brushes to be sure they are not chipped or broken. Make sure brush shunts are not frayed or broken. Replace any brush which shows damage.

Note: Chipped, burned or rough-faced brushes may indicate the commutator needs resurfacing.

- b. Move the brushes up and down in their carbon ways to be sure brushes slide freely.

Check the brush shunts to be sure they are not twisted or out of position. Make sure all brush-shunt terminal connections and all brushholder cable connections are tight.

Commutator

Inspect the commutator for possible flashover damage. The commutator should be clean, smooth, glossy and free of high mica, high bars, flat spots or rough surfaces.

If there are indications the commutator is out-of-round (e.g., variations in width of the ridge between brush paths), check the concentricity of the commutator with a dial indicator. Condemning limits for concentricity are listed in DATA section.

If the commutator requires grinding, refer to Commutator Resurfacing under BASIC REPAIRS section of this manual for instructions.

Creepage Band

Clean the creepage band (located on the commutator cap) with a clean cloth dipped in an approved solvent. Inspect the band for possible flashover damage.

Make sure the creepage band is tight on the commutator cap.

Flash Ring

Examine the flash ring for possible flashover damage. Wipe the flash ring clean. Keep ring free of dirt and varnish.

Insulation

Measure the insulation resistance with a megohmmeter (megger) to determine the condition of the insulation. If reading is low, make a further inspection to determine if insulation failure or excessive moisture is causing the low megohmmeter reading. Correct the cause of low readings before returning the motor to service.

Inspect all accessible parts of the field coil insulation for cracking and evidence of overheating.

Power Cables

Inspect the power cables for signs of excessive heating, poor insulation or mechanical damage. Assure all terminals are tight.

Mounting Bolts

Check all mounting bolts.

2. SEMI-ANNUALLY

- a. Perform inspection operations listed under Monthly section.
- b. Refer to DATA section for Brushholders Clearance dimensions, and check the clearance between the brushholders and the commutator surface.

If clearance, adjustment is required, refer to BASIC REPAIRS, Brushholders Clearance Adjustment section for instructions.

D. BASIC REPAIRS

1. Brush Replacement

Note: Brush spring pressure is pre-set and non adjustable for the brushholders used on these motors. Any brushholder that is damaged or has a low spring pressure should be replaced before installing new brushes. Spring pressure can be measured with a 20 lb. spring scale pulling radially on the brush pressure finger over the center of each brush. See DATA section for limits.

- a. Remove the commutator inspection covers.
- b. Disconnect the brush shunt from the terminal screw located on the brushholder body.
- c. Lift the pressure finger away from the brush to the toggled-up position. Remove the brush.
- d. Use dry, compressed air and blow the carbon dust from the carbonway.

WARNING: *Personal injury may result if proper eye protection is not worn when cleaning with compressed air.*

- e. Insert new brush and make sure brush slides freely in the carbonway.
- f. Carefully lower the pressure finger on the brush. Do not allow the finger to snap down on the brush as brush damage may result.
- g. Bolt the brush shunt terminals to the brushholder(s). Arrange the shunt strands so they clear the pressure fingers and tighten the terminal screw(s). Make sure shunts are not positioned under the pressure fingers. Check and tighten all brushholder cable connections.
- h. Seat the brushes with a white seater stone.

CAUTION: *When replacing brushes, use the recommended grade. Mixing of brush grades in the same motor or changing brushes to another grade is not recommended as this will seriously affect commutation, surface film, commutator and brush life.*

2. Brushholder Replacement

Removal

- Remove brushes from brushholders and cover the commutator with heavy paper.
- Disconnect the cable from the brushholder(s) involved.
- Remove bolt, washer and brushholder clamp. Lift the brushholder out of the frame.

Installation

- Position the brushholder in the frame with the brushholder studs resting in the clamp surfaces of the brushholder support.
- Install bolt and washer. Tighten bolt but do not torque until the brushholder-to-commutator clearance has been established.

Refer to the following section for instructions to adjust brushholder clearance.

- After brushholder clearance has been set, connect the brushholder cable, remove protective paper from commutator surface, and install the brushes.

3. Brushholder Clearance Adjustment

Refer to DATA section for brushholder-to-commutator clearance dimension and adjust brushholder as follows:

- Remove the brushes.

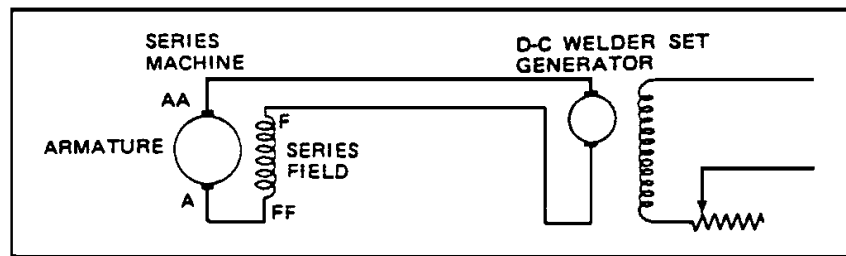


FIG. 3. DIAGRAM OF CONNECTIONS TO RUN SERIES MACHINE FROM A WELDING SET. E-671B

CAUTION: Do not allow brushholder to touch, bump or rest on the commutator.

- Insert a fiber gage (equal to the clearance dimension) between the commutator and the brushholder.

Do NOT use a metallic gage.

- Loosen the brushholder support bolt and move the brushholder against the fiber gage so clearance-to-commutator is the same as the gage thickness.
- Torque bolt to 225.250 lb. ft. and recheck the brushholder clearance gap.

4. Commutator Resurfacing

WARNING: For the safety of personnel during resurfacing operations, the following safety precautions must be adhered to:

1. A second man must be at the auxiliary power (welder) control station, ready to shut off power in case of an emergency during the grinding operation.
2. The grinding operator should wear goggles and a dust mask when resurfacing or blowing out the commutator.

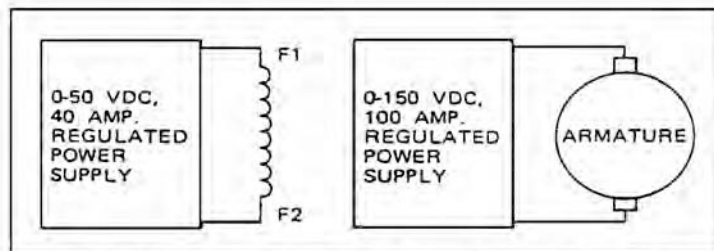


FIG. 3A. CONNECTIONS TO RUN A SHUNT MACHINE FROM A D-C POWER SOURCE. E-23930

CAUTION: Never use emery cloth on a commutator. The abrasive particles will not only scratch the surface, they are conductive and lodge between the commutator segments. A flashover may result.

Hand Stoning

If the commutator surface is mildly grooved, threaded, or burned, and only a small amount of copper has to be removed to correct the trouble, use a hand stone. Hand stoning will not correct an out-of-round commutator.

- a. Use a fine-grade stone ground to fit the commutator. It should also be of sufficient width to bridge any flat spots; otherwise, the stone will ride in and out of the flat and will not correct it.
- b. Remove one brushholder for access to the commutator.
- c. Run the motor at approximately 1000 RPM.
- d. Hold the stone firmly against the commutator surface, and with even pressure, move the stone back and forth longitudinally across the commutator surface.
- e. Blow away dust and sand with clean, dry, compressed air at 29 psi maximum.

WARNING: Proper eye protection, such as goggles, must be worn when cleaning with compressed air. Otherwise personal injury may result.

5. Sprocket Hub Mounting

Hub Fitting

To prevent a hub from slipping, it should have at least 75% fit on the shaft; i.e., at least 75% of the tapered bore of the hub should be in contact with the tapered fit on the shaft. Before mounting a hub, check and correct the fit as follows:

- a. Lightly cover the bore of the hub with a blueing compound such as Prussian Blue.
- b. Snap the cold hub forcefully on the shaft.
- c. Mark the relative angular position of hub with respect to the shaft.
- d. Remove the hub from the shaft. A convenient method of removal is by the use of two finely tapered steel wedges (hardened and ground) which are carefully driven between the sprocket hub and bearing seal on the shaft.
- e. Inspect the taper fit of the shaft; blueing of the hub bore should now show on the shaft. If at least 75% of shaft surface shows traces of blueing, the fit is satisfactory. If, however, only a few spots of blueing show on the shaft, the fit is not satisfactory.
- f. Dress down the blue spots on the shaft very lightly with a fine emery cloth such as No. 400A Triemite.
- g. Blue the hub bore again and repeat Steps 2, 4, 5 & 6. Be sure to place hub on the shaft in the same position as marked.

Generally, the fit will be improved, but the foregoing procedure may have to be repeated several times to obtain a 75% fit.

Under no circumstances use a lapping compound since lapping will produce a shoulder at the large end of the tapered fit. A shoulder will prevent a perfect fit when the hub is mounted hot; ie., when it is mounted in the advanced position.

- h. After a good fit has been obtained, thoroughly clean the shaft and the hub bore to remove all blueing, oil or grease. Then mount the hub.

Hub Mounting

Proper hub mounting is essential for successful operation of the sprocket drives.

- a. Thoroughly clean the hub fit on the shaft and bore of the hub (see procedure in General Maintenance of Rotating Equipment). Remove any scoring on the shaft or hub bore.
- b. Spot the cold hub on the shaft by hand and check for at least 75% fit. See hub fitting section. If necessary dress the shaft to obtain this fit.
- c. Trial mount the cold hub on the shaft. Measure and record the position of the hub with respect to the shaft. Make measurements with a micrometer indicator gage.

Mark points of measurements, and mark across the end of shaft and hub face so that the hub, when heated, can be mounted in exactly the same angular position, and so the advance measurement can be made from the same point.

CAUTION: Zero settings of advance gage must not be disturbed until all readings on the hub are completed.

- d. Mount the hub hot on the shaft so as to secure an advance from the cold position to the hot position along the axis of the shaft as indicated in this section. The ESTIMATED difference between shaft temperature and hub temperature (temperature rise) which will provide this advance is also given. The temperature difference is only as estimate and should be adjusted (if necessary) to maintain the advance within prescribed limits.

CAUTION: *The temperature of the hub must not exceed 250°C (482°F); otherwise, the hub may become annealed.*

<u>Advance (in.)</u>	<u>Degrees Rise Above Shaft Temperature</u>
0.120-0.130	215°C (387°F)
0.120-0.130	215°C (387°F)

Heat the hub in an oven until it has reached a uniform temperature (the desired number of degrees above shaft temperature). For example, if shaft temperature is 25°C (77°F), heat hub to 25°C (77°F) + 215°C (387°F) = 240°C (464°F)

An accurate method must be provided for measuring hub and shaft temperatures quickly before mounting the hub. This can best be done with a hand pyrometer. In using the pyrometer, place points of the gage inside the bore of the hub.

Measure temperature of shaft and hub with the same instrument.

- e. With hub bore and shaft taper clean, quickly mount the hot hub on the shaft in the same angular position as when cold. When the hub is nearly in engagement with the taper fit (not in actual contact), snap it forcibly into place with a quick push. It is important that the hot hub be instantly snapped into position before it has cooled; otherwise, it will freeze to the shaft and cannot be adjusted further.
- f. Check the hot or shrunk-on position of the hub on the shaft. The advance from cold to hot position along axis of the shaft must be held within the limits indicated. Check the actual advance with an indicator gage, located in the same relative position as used to measure the cold position in Step 3.

If the advance is not within specified limits, remove the hub and repeat the assembly procedure.

MATERIAL LIST **JOB #**

558830	PE BRG:	WS-850	HEATER:
558320	OPE BRG:	259805	CER. POST KIT:
14R50	COPPER TUBE:	3162813	535 GROMMET:
68-1/4X1/8	BRASS FITTING:	1603-2A	INSULATORS:
535MCM	535MCM CABLE:	97A145	HUB:
#4 AWG	#4 CABLE:	41D731089H-1	BRUSHHOLDER:
481A539P40	646 GROMMET:	97A150	ARM. CONNECTION
LGB6915915	646 CORD GRIP	97B342-1-2	T-BOX:
4/0 AWG	4/0 CABLE:	97B342-1-2SS	STAINLESS T-BOX:
HYB12B	#12 CABLE:	Industry Standard	SLINGER:
646	646 CABLE:	Industry Standard	ARM. RETAIN. NUT:
LCD250-38D-X	4/0 LUGS:	TB2573	535 CORD GRIP:
77926X3/4	MICA TAPE:	806 REGAL	2" LOCK NUT:
007 PSA	GLASS TAPE:	124825	1/2" SEAL TITE:
AG101	SOLDER:	ST90-50	90 DEG CONN:
DSD918-S153	CUTOUT SWITCH:	ST-50	STRAIGHT CONN:
1950-10	PRESSURE SWITCH:	124826	1" SEAL TITE
Industry Standard	TERMINAL STRIPS:	LT10090	1" 90° CONN:
17BC17C1	20PIN TERM. STRIP:	LT10090	1" STRAIGHT CONN:
20PYLE	20 PIN CONNECTOR:	MF10RI	GLYPHOL:
88465901AAP13	INDICATOR:	WYYZ02-290-000	FRAME:
41A321555P1	20 PIN JUMPER:	10-Industry Standard	Industry Standard BRUSH:
41D732292	BLOWER:	98A154	POLE PIECE:
41D732292SS	STAINLESS BLOWER:		