



GE Industrial Systems

Instructions

Vertical Induction Motors

Normal Thrust – Solid-Shaft

***Including Aerator and
Sewage Pump Motors***

***Frames 182-5011 NEMA Type P Base
Weather Protected Type I & II
TEFC & Explosion-Proof***

SAFETY PRECAUTIONS



High voltage and rotating parts can cause serious or fatal injuries. Installation, operation, and maintenance of electric machinery should be performed by qualified personnel. Familiarization with NEMA Publication MG-2, Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators, the National Electrical Code, and sound local practices is recommended.

For equipment covered in 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.
- Avoid bypassing or rendering inoperative any safeguards or protective devices.
- Avoid use of automatic-reset thermal protection where unexpected starting of equipment might be hazardous to personnel.
- Avoid contact with capacitors until safe discharge procedures have been followed.
- Be sure that the shaft key is fully captive before the motor is energized.

- Avoid extended exposure in close proximity to machinery with high noise levels.
- Use proper care and procedures in handling, lifting, installing, operating, and maintaining the equipment.
- Do not lift anything but the motor with the motor lifting means.

Safe maintenance practices by qualified personnel are imperative. Before starting maintenance procedures, be positive that:

- Equipment connected to the shaft will not cause mechanical rotation.
- Main machine windings and all accessory devices associated with the work area are disconnected from electrical power sources.

If a high-potential insulation test is required, procedure and precautions outlined in NEMA Standards MG-1 and MG-2 should be followed.

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

These instructions do not purport to cover all of the 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 General Electric Company.

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Table of Contents

<u>Subject</u>	<u>Page</u>
Safety Warnings.....	2
Introduction	4
V-Belt Drive.....	4
Receiving, Handling, and Storage.....	4
Unpacking	5
Installation	5
Location and Mounting	5
Pump and System Precautions	6
Alignment of Solid Shaft Motors	6
Power Supply and Connections.....	6
Wiring and Grounding.....	6
Allowable Voltage Frequency	6
Position of the Conduit Box	6
Lubrication	6
Operation	7
Steps Prior to Initial Startup.....	7
Initial Start	7
Jogging and Repeat Starts	8
Maintenance	8
General.....	8
Explosion-Proof Motors for Hazardous Locations.....	8
General Cleanliness.....	8
Relubrication.....	9
Bearing Replacement	9
Insulation and Winding Maintenance.....	9
General	9
Vacuum and Compressed Air Cleaning.....	9
Cleaning with Water and Detergent.....	9
Cleaning with Solvents	10
Revarnishing Windings	10
Renewal Parts	10
Trouble Shooting Chart	11

**VERTICAL INDUCTION MOTORS
NORMAL THRUST – SOLID-SHAFT
INCLUDING AERATOR AND SEWAGE PUMP MOTORS
FRAMES 182-5011 NEMA TYPE P BASE
WEATHER PROTECTED TYPE I & II TEFC & EXPLOSION-PROOF**

I. INTRODUCTION

General Electric normal-thrust, aerator and sewage pump vertical motors covered by these instructions are carefully constructed of high-quality materials and are designed to give long and trouble-free service when properly installed and maintained. Normal-thrust motors are generally used to drive pumps but are sometimes used for belt-drive applications.

The enclosure and the bearing lubrication system of these vertical motors are designed specifically for operation with motor mounted vertically with shaft downward. These motors should not be operated in any other position without approval of the General Electric Company.

Normal-thrust, aerator and sewage pump motors generally use grease-lubricated ball bearings at each end of the motor. These motors are intended to carry relatively light axial thrust loads, either up or down. They can also carry some radial load, or a combination of axial and radial loads.

Generally the lower bearing is locked in place in the lower endshield and locked onto the shaft so it carries all thrust loads either up or down. The upper bearing has clearance both above and below its outer ring so it is free to move up and down and keep the bearings from being axially loaded by differential thermal expansion between the shaft and the stationary parts of the motor. The upper bearing then serves only as a guide bearing. See Figures 1 and 2.

Some of the larger normal-thrust motors and all aerator and sewage pump motors use a double-row ball bearing at the lower end to obtain greater capacity. This is shown on the left side of Figures 1 and 2.

Since overloading greatly reduces bearing life, motor bearings should not be loaded beyond their rated capacity.

A. V-Belt Drive

Since belting places relatively high radial loads on the shaft and bearings, motors must be specifically ordered for such service. To limit these loads to reasonable values, adhere to the minimum motor sheave diameter and maximum sheave width specified by the General Electric Company. Belt speed, distance sheave centerlines, and sheave diameter ratio should be within

the limits of good belting practice as specified by the belt manufacturer. The belt speeds should not exceed 5,000 feet per minute unless otherwise recommended by the manufacturer of the belt.

This instruction book applies to motors with Weather-Protected I, Weather-Protected II, Totally Enclosed-Fan Cooled (TEFC), or Totally Enclosed-Explosion-Proof enclosures as defined by NEMA (WP-II enclosure is not available in 440 and smaller frame series).

Weather-Protected I motor construction is shown in Figure 1.

Weather-Protected II motor enclosures are characterized by additional protection at the air inlet and outlet passages and by gaskets, drains, and other features to make it suitable for use outdoors in severe climates. Filters can be supplied for the air-inlet openings. When used, they should be cleaned periodically since clogged filters restrict the amount of cooling air and cause the motor to overheat. Gages are sometimes used to measure the pressure drop across the filter and thus indicate its condition. Filters should be cleaned when the gage reads over 0.4" of water.

TEFC and explosion-proof motor construction is shown in Figure 2. Enclosed motors are characterized by an enclosure and ventilating system that prevents the free exchange of air between the inside and outside of the motor. The air inside the motor is circulated by the rotor fans to carry heat to the enclosing parts while an external fan blows ambient air over the motor to complete the cooling process.

II. RECEIVING, HANDLING, AND STORAGE

Each motor should be carefully examined when received and a claim filed with the carrier for any damage. The nearest office of the General Electric Company may offer guidance.

	<i>The motor should be lifted by the lugs provided. These lugs are intended for lifting the motor only and must not be used to lift any additional weight. Be careful not to touch overhead power lines with lifting equipment. Failure to observe this warning may result in personal injury or death.</i>
Warning	

If the motor is not to be installed immediately, it should be stored in a clean, dry location. Precautions should be taken to prevent the entrance of moisture, dust, or dirt during storage and installation. Precautions are taken by the factory to guard against corrosion. The machined parts are slushed to prevent rust during shipment. Examine the parts carefully for rust and moisture if the equipment is to be stored and re-slush where necessary.

These motors have grease-lubricated bearings which are packed with the proper amount of grease at the factory and do not require regreasing until they have been in service for a time, unless they have been stored for a long time under adverse conditions.

See instructions under **Maintenance** for lubrication recommendations.

Motors in storage and motors that are to stand idle for a prolonged period and be subjected to moisture from condensation should have the bearing housings filled with grease to minimize corrosion.

To fill bearings completely, add grease until it comes all the way out of the relief passage. When the motor is again started, run it with the relief plug removed for about ten minutes to expel excess grease.

During storage, windings should be protected from excessive moisture absorption by some safe and reliable method of heating. Space heaters, if supplied, may be used for this purpose. The temperature of the windings should always be maintained a few degrees above the temperature of the surrounding air. It is recommended that motors in storage be inspected, the windings meggered, and a log of pertinent data kept. Any significant decrease in insulation resistance should be investigated.

If a motor is to be in storage for over one year, it is recommended that competent technical inspection service be obtained to ensure that the storage has been adequate and that the motor is suitable for service. Contact your nearest General Electric Sales office to arrange for inspection service.

III. **UNPACKING**

If the machine or machine parts have been exposed to low temperatures, unpack it only after it has reached the temperature of the room in which it will be unpacked or located; otherwise sweating will occur.

IV. **INSTALLATION**

 Warning	<p><i>Installation should be in accordance with the National Electrical Code and consistent with sound local practices. Coupling guards and belt enclosures should be installed as needed to protect against accidental contact with moving parts. Machines accessible to personnel should be further guarded by screening, guardrails or other suitable enclosure to prevent anyone from coming into contact with the equipment. This is especially important for motors that are remotely or automatically controlled or have automatic re-setting overload relays, since such motors may start unexpectedly. Failure to observe these precautions may result in injury or death to personnel.</i></p>
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A. **Location and Mounting**

Allow enough space around the motor to permit free flow of ventilating air and to maintain an ambient temperature not over 40° C. Where a choice of locations is possible, install the motor so that it will be subjected to the least amount of dirt, dust, liquids, or other harmful materials. Mount the motor securely on a level, firm foundation, align accurately with the driven equipment, and tighten mounting bolts securely.

For BELT-DRIVE installations, align the sheaves carefully to avoid axial thrust on the bearings and excessive belt wear. Tighten the belts only enough to prevent slipping. Excessive tension will reduce bearing life and may cause the shaft to break.

 Warning	<p><i>All belts should be enclosed to prevent injury from thrown parts in case a belt should break in service.</i></p>
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Weather-Protected Type I motors may be installed in indoor locations with relatively high moisture content or sheltered outdoor locations in dry climates.

Weather-Protected Type II motors may be installed outdoors. Use filters in unclean areas.

Because of their special enclosure features, enclosed motors can be operated out-of-doors and in dirty locations.

Explosion-proof motors suitable for use in hazardous locations bear the Underwriters Laboratories Label and should be applied only in the areas for which they are designed, as specified in the National Electrical Code (See **Motors For Hazardous Locations**).

	<i>If ignitable dust or lint is present around WP-I or WP-II motors, the surface temperature of space heaters, if supplied, should not exceed 80% of the ignition temperature. Refer to space heater nameplate or factory for information on surface temperature. Dust and/or lint should not be allowed to build up around the surface of the space heaters. Failure to observe these precautions may result in damage to equipment, injury to personnel, or both.</i>
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	<i>Installation of the machine where hazardous, flammable, or combustible vapors or dusts present a possibility of explosion or fire should be in accordance with the National Electrical Code, Articles 500-503, and consistent with sound local practices. Extreme care is required for all explosion-proof motors and all motors supplied with an explosion-proof or dust-ignition proof accessory device or conduit box since any nicks or burrs in the sealing surfaces during disassembly and reassembly may destroy the explosion-proof or dust-ignition proof features. Failure to observe these precautions may result in damage to the equipment, injury to personnel, or both.</i>
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B. Pump and System Precautions

Some precautions are necessary to assure satisfactory operation of motors in pumping service. The packing gland in the pump head should be kept in good condition so that the liquid being pumped will not be forced out along the shaft and enter the motor through the lower bearing housing.

Motors driving pumps in pressure systems where the pressure is maintained after shutdown should be protected from overspeeding by check valves.

The SYSTEM REED CRITICAL FREQUENCY should be 25% above or below motor operating speed in order to avoid excessive vibration.

C. Alignment of Solid Shaft Motors

Accurate mechanical lineup is essential for successful operation. Mechanical vibration and roughness when the

motor is running may indicate poor alignment. In general, lineup by straight edge across, and feeler gages between coupling halves is not sufficiently accurate. It is recommended that the lineup be checked with dial indicators. The space between coupling hubs should be maintained as recommended by the coupling manufacturer.

D. Power Supply and Connections

1. Wiring and Grounding

	<i>Motor and control wiring, overload protection, and grounding should be in accordance with the National Electrical Code and consistent with sound local practices. Failure to observe these precautions may result in damage to the equipment, injury to personnel, or both.</i>
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Stator winding connections should be made as shown on the connection diagram or in accordance with the wiring diagram attached to the inside of the conduit box cover. For 3-lead motors no connection diagram is needed or supplied.

The motor frame may be grounded by attaching a ground strap from a known ground point to the bronze grounding bolt in the conduit box.

2. Allowable Voltage and Frequency

The power supply must agree with the motor nameplate voltage and frequency. Motors will operate (but with characteristics somewhat different from nameplate values) on line voltages within $\pm 10\%$ of nameplate value or frequency within $\pm 5\%$ and a combined variation not to exceed $\pm 10\%$.

3. Position of the Conduit Box

When mounting conditions permit, the conduit box may be turned so that entrance can be made upward, downward, or from either side.

E. Lubrication

All grease-lubricated bearings are packed with the proper amount of grease at the factory and do not require regreasing initially until they have been in service for a time, unless they have been stored for a long time under adverse conditions.

See instructions under **Maintenance** for lubrication recommendations.

V. OPERATION

	Before energizing the motor for the first time or after an extended shutdown, it is advisable to check insulation resistance, power supply and mechanical freedom of the motor. If the motor has been stored in a damp location, dry it out thoroughly before operating.
Caution	

	Be sure that the motor is not running and the power supply is disconnected before working on the motor.
Warning	

A. Steps Prior to Initial Start-Up

1. Check insulation resistance as indicated in the caution above.

	Before measuring insulation resistance, the machine must be at standstill and all windings to be tested must be electrically connected to the frame and to ground for a time sufficient to remove all residual electrostatic charge. Failure to observe these precautions may result in injury to personnel.
Warning	

In accordance with established standards, the recommended minimum insulation resistance for the stator winding is as follows:

$$R_S = \frac{V_S}{1000} + 1$$

Where R_S is the recommended minimum insulation resistance in megohms at 40°C of the entire stator winding obtained by applying direct potential to the entire winding for one minute, and V_S is rated machine voltage.

NOTE: See IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machines Publication No. 43 for more complete information.

If the insulation resistance is lower than this value, it may be wet and it is advisable to eliminate the moisture in one of the following ways

a. Dry the stator in an air circulating oven with the air surrounding the part at 95°C to 115°C until the stator has been above 90°C for at least four hours. Then the air temperature may be raised to 135°C to 155°C. Continue to heat until the insulation resistance is constant for a one-half hour period.

b. Enclose the motor with canvas or similar covering, leaving a hole at the top for moisture to

escape. Insert heating units or lamps and leave them on until the insulation resistance is constant for one-half hour period. Be careful not to get heating units so close to the winding that they cause localized damage.

c. With the rotor locked and using approximately 10% of rated voltage, pass a current through the stator windings. Increase the current gradually until the temperature reaches 90°C. Do not exceed this temperature. Maintain a temperature of 90° C until the insulation resistance becomes constant for a one-half hour period.

2. Whenever possible, examine the interior of the machine for loose objects or debris which may have accumulated and remove any foreign material.

3. If possible, turn the rotor by hand to be sure that it rotates freely.

4. Check all connections with the connection diagram. Check all accessible factory-made connections for tightness to make sure none has become loose during shipment.

5. If possible, leave motor uncoupled (or uncouple it) for initial operation so that motor vibration, noise, current, and bearings can be checked uncoupled before they are masked by the driven equipment.

6. When the driven machine is likely to be damaged by the wrong direction of rotation, it is imperative to uncouple the motor from its load during the initial start and make certain that it rotates in the correct direction. If it is necessary to change rotation, interchange any two line leads. For multispeed motors, check each speed independently.

Some motors are designed for unidirectional rotation. Rotation of these motors must be in accordance with the rotation indicated on the nameplate and the outline furnished with the equipment.

B. Initial Start

1. After inspecting the machine carefully as outlined above, make the initial start by following the regular sequence of starting operations in the control instructions.

2. Run the motor uncoupled initially, if possible, checking for abnormal noise, vibration, or bearing temperatures and for current and voltage balance. Then check motor operation under load for an initial period of at least one hour to observe whether any unusual noise or hotspots develop.

3. In the event of excessive vibration or unusual noise, remove all power and disconnect the machine from the load and check the mounting and alignment.

4. Space heaters should be de-energized during motor operation.

5. Check line voltage on all three phases to be sure it is balanced and within 10% of motor rated voltage with motor drawing load current.

6. Check the operating current against the nameplate value. Do not exceed the value of nameplate amperes X service factor (if any) under steady continuous load. Also, check to be sure that current in all three lines is balanced.

C. Jogging and Repeat Starts

 Caution	<i>Repeated starts and/or jogs of induction motors greatly reduce the life of the winding insulation. The heat produced by each acceleration or job is much more than that dissipated by the motor at full load. If it is necessary to repeatedly start or jog a motor, it is advisable to check the application with the local General Electric sales office.</i>
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Check motor heating but do not depend on your hand to determine temperature. Use the temperature detectors furnished in the motor if there are any (e.g., RTD's or thermocouples), or use a thermometer. If there is any doubt about the safe operating temperature, take the temperature of the part in question and confer with the nearest sales office of the General Electric Company. Give full details, including all nameplate information.

Overheating of the motor may be caused by improper ventilation, excessive ambient temperature, dirty conditions, excessive current due to overload, unbalanced AC voltage, or (if a variable speed controller is used) harmonics in power supplied to the motor.

VI. MAINTENANCE

 Warning	<i>Before initiating maintenance procedures, disconnect all power sources to the motor and accessories</i> <i>For machines equipped with surge capacitors do not handle capacitor until it is discharged by a conductor simultaneously touching all terminals and leads, including ground. This discharge conductor should be insulated for handling.</i> <i>Replace all normal grounding connections prior to operation.</i> <i>Failure to observe these precautions may result in injury to personnel.</i>
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A. General

Inspect the motor at regular intervals, as determined by service conditions. Keep the motor clean and the ventilation openings clear.

In addition to a daily observation of the overall conditions, it is recommended that a regular inspection routine be set up to check periodically the following items:

1. General Cleanliness
2. Insulation and Windings
3. Lubrication and Bearings
4. Coupling Bolt Tightness

B. Explosion-Proof Motors for Hazardous Locations

Motors which are suitable for use in hazardous locations have special features and are called explosion-proof motors or dust ignition-proof motors. They bear the Underwriters Laboratories label which specifies the particular type of location in which the motor may be operated.

Special features include wide metal-to-metal joints with limited clearances between surfaces; the scaling of leads into the frame; enclosing parts and holding bolts of proper design for strength; fans, seals, and non-reverse couplings of non-sparking metals; the avoidance of removable plugs in the enclosure, etc.

 Warning	<i>Motors for hazardous locations require more than ordinary care in their maintenance and repair to assure their continued safety. When major repairs are necessary or new parts are required, it is recommended that the motor be sent to an authorized General Electric service shop.</i>
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C. General Cleanliness

The interior and exterior of the machine should be kept free from dirt, oil, grease, and conducting dust. Oily vapor, debris, or dust may build up and block off ventilation. Any of these contaminants can lead to early motor failure. Motors should be disassembled and thoroughly cleaned periodically as needed. While TEFC motors can be run in dirty areas, better service may be expected if they are kept reasonably clean.

Motors may be blown out with dry, compressed air of moderate pressure. However, cleaning by suction is preferred because of the possibility of water in the compressed air lines and the danger of blowing metal chips into the insulation with compressed air.

**Warning**

To prevent injury to eyes and respiratory organs, safety glasses and suitable ventilation or other protective equipment should be used. Operator must not use compressed air to remove dirt or dust from his person or clothing.

D. Relubrication

Motors covered by these instructions employ grease lubrication for both the upper (guide) bearing and the lower (thrust) bearing.

The bearing housings are packed at the factory with sufficient longlife grease for an initial operating period.

Since the oil in the grease will ultimately become depleted, it is necessary to regrease at intervals consistent with the service. The following recommendations are offered as a guide in determining the relubrication period.

Guide bearings in vertical motors carry relatively light loads, and, under normal conditions of operation, can be regreased every three to five years. When conditions are more severe (high temperatures, dirty locations, motor running continuously, etc.), regrease every one to two years.

Regrease the thrust bearings of motors with speeds above 1800 rpm every 1000 hours of operation with the interval not to exceed three months. For motors with speeds 1800 rpm and below, regrease every 2000 hours of operation, with the interval not to exceed six months.

Relubrication procedure is as follows: Remove the grease relief plug and free the relief passage of hardened grease. Wipe the grease fitting clean. Or, if no fitting is supplied, replace the 1/8" pipe plug with a standard fitting.

For best results, use GE long-life grease (No. D6A2C5 as specified on motor nameplate). Take care to exclude dirt from the bearing housing and lubricant. With the motor at standstill, add grease, using a hand-operated gun, until the grease begins to move in the relief passage. Allow the motor to run about ten minutes before replacing the relief plug, to purge excess grease.

Since the above method tends to purge the bearing housing of used grease; complete removal of all grease should be required only at infrequent intervals. Whenever the motor is disassembled for general cleaning and reconditioning, the housing should be cleaned of old grease, using a suitable cleaning solvent, and dried thoroughly. Refer to the mixture described under **Insulation and Winding Maintenance** below. Pack the cavity above the bearing with new grease until it is approximately 2/3 full before reassembling.

E. Bearing Replacement

In general, replacement bearings should be of the same type and installed in the same relative position as the other bearings.

When removing bearings, apply steady, even pressure parallel to the shaft centerline. Apply this pressure to the inner race whenever possible.

F. Insulation and Winding Maintenance

1. General

For long life and satisfactory operation, insulated windings should be kept clean and free of dirt, oil, metal particles and other contaminants. A variety of satisfactory and acceptable methods are available for keeping equipment clean. The choice of method will depend greatly on time, availability of equipment, and on the insulation system. However, vacuum and/or compressed air cleaning with nonmetallic hose tips should proceed cleaning with water and detergent or with solvents. Tightly adhering dirt may require gently brushing or wiping to get it loose.

**Warning**

To prevent injury to eyes and respiratory organs, safety glasses and suitable ventilation or other protective equipment should be used.

2. Vacuum and Compressed Air Cleaning

Compressed air may be used to remove loose dirt and dust from air passages such as air ducts. Suction should be used to remove dirt and dust particles into the windings and damaging the coils.

**Caution**

Care must be taken to make sure that the air supply is dry and that excessive air pressure is not used. Generally a pressure of not more than 30 psi is recommended.

**Warning**

Operator must not use compressed air to remove dirt or dust from his person or clothing.

3. Cleaning with Water and Detergent

This method is very effective in cleaning windings when used with a low-pressure steam jenny (maximum steam flow 30 PSI and 90°C).

 Caution	To minimize possible damage to varnish and insulation, a fairly neutral, non-conducting type of detergent such as Dubois Flow should be used. A pint of detergent to 20 gallons of water is recommended.
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If a steam jenny is not available, the cleaning solution may be applied with warm water by a spray gun. After the cleaning operation, the windings should be rinsed with water or low-pressure steam.

It is advisable to dry the windings. Refer back to **Insulation Resistance** section for instructions on how to proceed.

4. Cleaning With Solvents

 Warning	Many cleaning fluids are flammable and/or toxic. To prevent injury to personnel and property, care should be taken to avoid flames, sparks, etc. Safety glasses should be used and contact with the skin should be avoided. The area should be well ventilated or protective equipment should be used.
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Although cleaning with water and detergent is the preferred method, solvent cleaning may be used when heat-drying facilities are not available.

1,1,1 Trichloroethane is recommended for use as the cleaning solvent. Solvent cleaning of silicone-insulated windings (Class H insulated machines) is not recommended.

 Warning	While 1,1,1, Trichloroethane is considered to be non-flammable and has a relatively low order of toxicity, it should be used only in a well ventilated area that is free from open flames. Avoid prolonged exposure to its vapor. Failure to observe these precautions may result in injury to personnel.
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Windings cleaned with solvent should be dried thoroughly by circulation of dry air before voltage is applied.

5. Revarnishing Windings

After several cleanings with water and detergent, it may be necessary to re-varnish the windings. GE 9522 or equivalent varnish treatment is recommended for Class B and Class F systems. This varnish is available from the General Electric Company Insulating Materials Department of GE Service Shops.

All systems treated with varnish No. 9522 or equivalent must be baked until the windings are at 150°C for four hours.

VII. RENEWAL PARTS

When ordering parts, give description and state quantity of parts desired, together with the nameplate rating, model, and serial number of the motor. For couplings, also specify the type, bore, and keyway size.

Requests for additional copies of these instructions or inquiries for specific information should be addressed to the nearest sales office of the General Electric Company.

* One commercial source of 1,1,1 Trichloroethane is Chlorothene NU, which is a trademark of the Dow Chemical Company, Midland, Michigan.

VIII. TROUBLE SHOOTING CHART

Affected Parts	Difficulty	What to Check
Windings	Overheating	<ul style="list-style-type: none"> • Calibration of measuring instrument • Excessive load • Unbalanced AC current • Improper or restricted ventilation • Excessive ambient temperature • Short circuited coil or windings • Dirty windings • Unbalanced voltage • Harmonics in power supply (variable frequency control) • Fan broken
Bearings	Overheating	<ul style="list-style-type: none"> • Calibration of measuring instrument • Worn out or dirty oil • Insufficient oil • Misalignment • Excessive thrust or radial loading • Shaft currents • Insufficient cooling water • Improper end-play • Insufficient down-thrust (on SRB) • Fan broken
Bearing Housing	Oil Leaks	<ul style="list-style-type: none"> • Incorrect grade of oil (type or viscosity) • Loose fittings • Cracked/porous casting • Over-filled • Water in oil
Motor	Excessive Vibration	<ul style="list-style-type: none"> • Unbalance • Misalignment • Improper or settled foundation • Non-uniform air gap • Rubbing parts • Bent shaft • Unbalanced stator current • Damaged bearings • Reed critical frequency • Incorrect end-play • Fan broken
Motor	Failure to Start	<ul style="list-style-type: none"> • Wrong transformer taps • Wrong connections • Open circuit • Excessive line drop (low voltage at motor) • Excessive load • Rotor rubs • Wrong direction of rotation
Insulation	Low Insulation Resistance or Insulation Failure	<ul style="list-style-type: none"> • Moisture, dirt, metal particles, oil, or other contaminants on the insulated windings • Wrong voltage • Excessive temperature • Voltage surges/lightning • Mechanical damage • Excessive vibration with resultant mechanical damage • Single-phasing

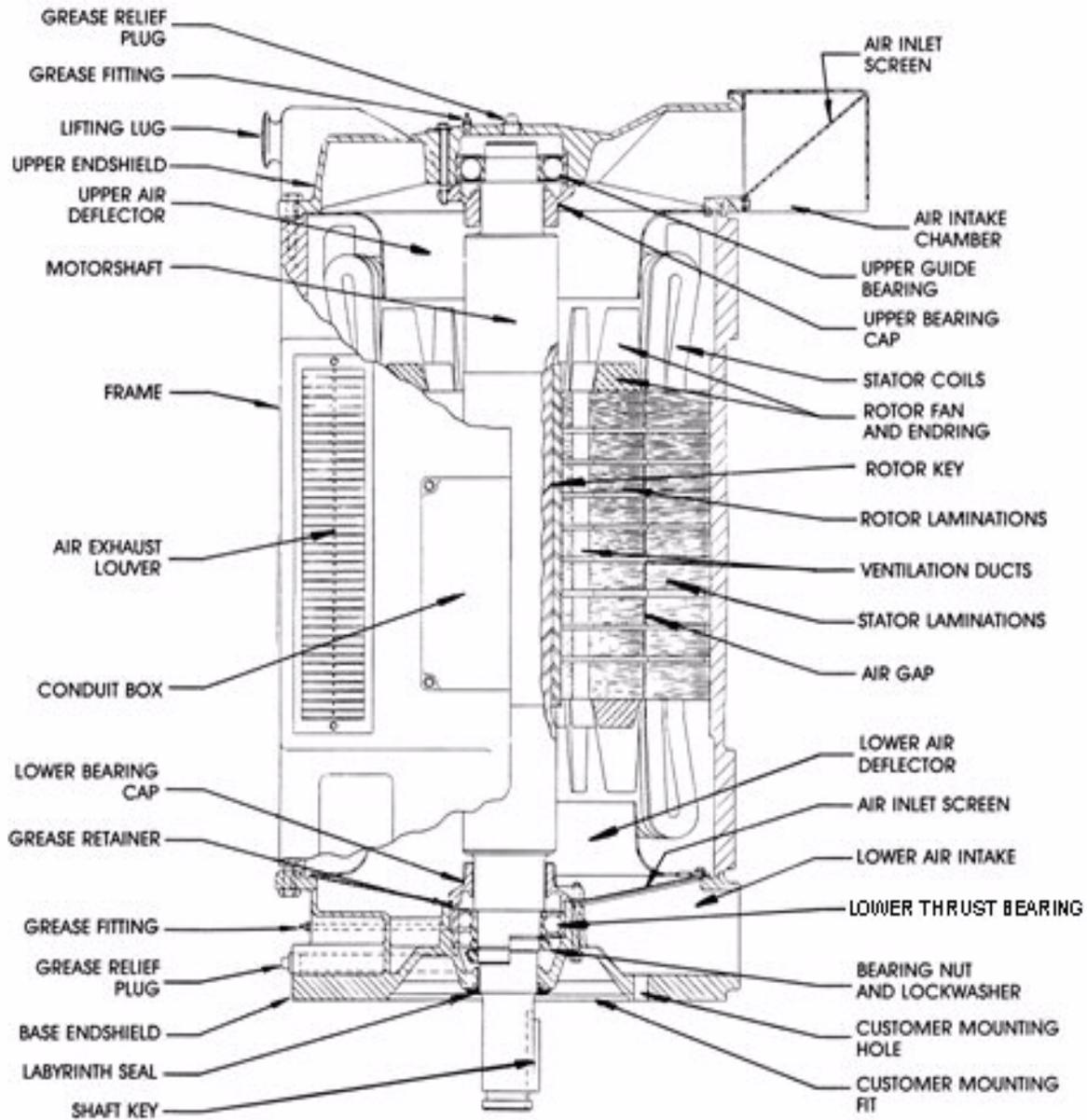


Figure 1

**Typical Solid-Shaft Normal-Thrust WP-I Motor
With Grease-Lubricated Ball Thrust And Guide Bearings.
Double Row Thrust Bearing On Left Is Used In All
Sewage And Aerator Motors And In All 5011 Frame Normal-Thrust Motors**

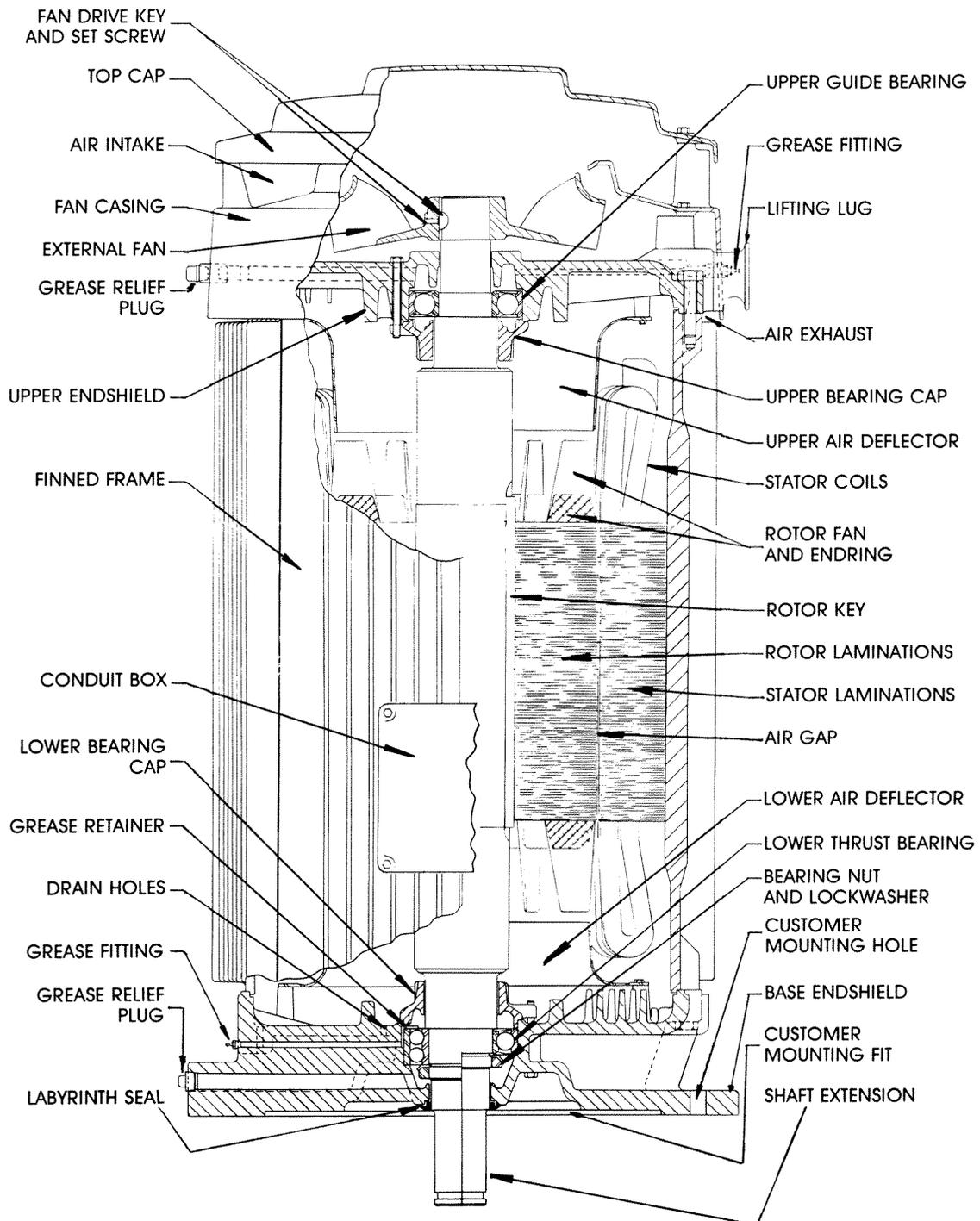


Figure 2

**Typical Solid-Shaft Normal-Thrust TEFC Motor
 With Grease-Lubricated Ball Thrust and Guide Bearings.
 Double Row Thrust Bearing On Left Is Used In All
 Sewage and Aerator Motors And In All 5011 Frame Normal-Thrust Motors**

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Reader Comments

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General Rating

	<i>Excellent</i>	<i>Good</i>	<i>Fair</i>	<i>Poor</i>	<i>Additional Comments</i>
Contents	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
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Clarity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
Completeness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	_____
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Specific Suggestions (Corrections, information that could be expanded on, and such.)

<i>Page No.</i>	<i>Comments</i>
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Other Comments (What you like, what could be added, how to improve, and such.) _____

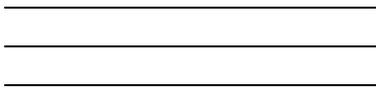
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