GE Industrial Systems

Instructions

Vertical Induction Motors

High Thrust Hollow & Solid-Shaft and In-Line Solid-Shaft

Frames 182-405 NEMA Type P Base 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 by-passing 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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VERTICAL INDUCTION MOTORS
HIGH THRUST HOLLOW & SOLID-SHAFT AND IN-LINE SOLID SHAFT
FRAMES 182-405 NEMA P BASE
TEFC & EXPLOSION-PROOF

I. INTRODUCTION

General Electric High-Thrust 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. These motors are generally used to drive pumps.

Both HOLLOW-SHAFT and SOLID-SHAFT motors are described in this instruction book. Hollow-shaft construction is available in frame sizes 213 and larger whereas solid-shaft construction is available in 182 and larger. Figure 1 shows a typical 213-286 frame hollow-shaft high thrust motor and Figure 2 shows the 324-405 frame construction. Solid-shaft construction is shown in Figures 3 and 4 with the motor shaft extending out the bottom of the motor. Solid-shaft high-thrust motors are not suitable for driving loads that impose significant radial load on the motor shaft**; they should not, for example, be used for belt-drive applications.**

Motors may be supplied with different bearing arrangements for various external thrust conditions imposed by the pump, such as different magnitudes of down-thrust and either momentary or continuous up-thrust. A typical high-thrust motor with angular-contact ball bearings is shown in Figures 1 and 2. This standard construction is for high continuous down-thrust and is suitable for momentary up-thrust equal to 30% of the rated down-thrust capacity of a high-thrust motor. NOTE THAT ANGULAR-CONTACT BEARINGS CAN ONLY CARRY THRUST IN ONE DIRECTION.
IN-LINE motors (designed to be mounted on pumps which are directly in the pipe-line, and hence called IN-LINE motors) are also covered by this instruction book. These motors have two opposed-mounted angular-contact ball thrust bearings so they can carry either up or down thrust. The guide bearing is a radial-ball type. IN-LINE motors are always of the solid-shaft type. This clamped construction is shown on Figures 3a and 4a.

Since overloading greatly reduces bearing life, the amount of thrust applied should not exceed the recommended values.

This instruction book applies to motors with either Totally Enclosed Fan Cooled or Totally Enclosed Fan Cooled-Explosion-Proof enclosures as defined by NEMA.

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.

> **Warning**
>
> ***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.***

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.

Motors are shipped without oil in the bearing reservoirs (320 frame and larger). An oil film remains on the bearings, but if the storage period is to exceed three months, the reservoirs should be filled. It is suggested that such oil-filled motors be conspicuously tagged in order to prevent mishandling, which would cause oil spillage and subsequent damage to the internal parts of the motor. When filling for storage, fill to the maximum level shown on the gage or approximately 1/2" over the mark showing the standstill level. Before operating the motor, drain this oil and refill with fresh oil.

See instructions under RELUBRICATION for oil recommendations.

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 main tained 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.

A. 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.

III. INSTALLATION

> **Warning**
>
> ***Installation should be in accordance with the National Electrical Code and consistent with sound local practices. Coupling guards 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 of death to personnel.***

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 40º. 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.

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 LOCATION).

Warning

Installation of the machine where hazardous, flammable, or combustible vapors or dusts present a possiblity 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 or TEFC 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.

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 or non-reverse couplings.

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. Couplings for Hollow-Shaft Motors

1. General

Vertical hollow-shaft motors are designed for driving deep-well, turbine-type pumps and can be equipped with either self-release, bolted, or non-reverse couplings as described in the following sections. These couplings are located at the top of the motor and allow pump impeller position to be adjusted easily. The type of coupling is specified by the customer. Remove the top cover and fan casing for access to the coupling

Two slots are provided in the outside rim of the coupling so that a bar can be inserted to keep the assembly from turning while the adjustment of pump impeller clearance is being made. The motor fan must be removed for access to these holes, but fan removal is a normal step during motor installation since it is mounted on the upper half-coupling. A coupling bolt can be screwed into one of the extra tapped holes in the top endshield to provide a stop for the bar.

To prevent breakage, coupling bolts must be tightened to torque values indicated below for bolted or non-reverse couplings.

Bolt Size	Torque
1/4	10 lb-ft
5/16	20 lb-ft
3/8	37 lb-ft
1/2	90 lb-ft
5/8	180 lb-ft
3/4	320 lb-ft
1	710 lb-ft

Caution

It shall be the installer's responsibility in all cases to ascertain that these torque values are used and maintained. This shall include those instances when the coupling comes mounted in the motor. Failure to comply may cause the coupling blots to break with resultant extensive damage to the equipment.

2. Self-Release Couplings

Warning

Self release couplings must not be used with explosion-proof motors. Only non-reverse couplings with non-sparking ratchets should be used with explosion-proof or dust ignition-proof motors that drive pumps with sectional shafts. If the pump has a solid, one piece shaft, a bolted coupling may be used.

Should the motor accidentally be run in the reverse direction, the pump line-shaft joints may unscrew. The self-release coupling acts to limit the amount of this unscrewing. In normal operation, torque from the motor is transmitted by the lower half-coupling through the driving pins to the upper half-coupling, and then to the pump shaft. If reversal occurs and the pump shaft starts to unscrew and lengthen, the up per half of the self-release coupling is lifted off of the driving pins, thus uncoupling the pump from the motor. See Figure 2, where a self-release coupling is shown to the left of the shaft center-line.

NOTE: Self-release couplings cannot carry up-thrust.

To install a motor with a self-release coupling, first lift off the upper half-coupling and the fan attached to it, and remove the fan from the coupling. Then lower the motor onto the pump with pump shaft through motor shaft. Next, set the upper half-coupling into place on the lower half-coupling and put the gib-key in place. Then put the pump shaft nut in place, adjust the pump and lock the nut. Finally, set the fan on top of the upper half-coupling and secure it with its 3 capscrews.

Proper functioning of a self-release coupling depends upon several factors. The pump shaft adjusting nut must be securely attached to the top half-coupling, and the top half-coupling must not bind on the lower half. Otherwise, the adjusting nut lock-screw may break instead of the coupling halves separating. Should this happen, the motor would continue to unscrew. Serious damage to both motor and line shaft may result. Clearance between the coupling halves should be checked by placing the top half-coupling in position prior to installing the motor. It should drop into place, and rest solidly on the lower half-coupling, without forcing.

Proper alignment of the pump head-shaft within the motor hollow shaft is also important. After the coupling releases, it no longer holds the pump shaft centered. If the alignment is not good, the motor shaft which is still rotating may rub the pump shaft which has stopped, and damage will result.

A third requirement is that the distance between the top of the pump shaft and the inside of the top cap be at least enough to allow the top half-coupling, when it tries to release, to clear the pins before the shaft hits the cap. Check this clearance after the adjusting nut has been drawn up to its final position. To facilitate making the check, the motor outline print shows a maximum dimension “XH” from the top of the coupling to the top of the pump shaft. Adhering to this design limit will allow the shaft and coupling to lift enough to clear the pins and still leave a small clearance between the shaft and cap. For standard motors, “XH” is as shown in Table I.

Table I

Frame Size	XH
213-215	2.00 inches
254-256	2.25 inches
284-286	2.50 inches
324-326	3.75 inches
364-365	3.75 inches
404-405	4.00 inches

Depending upon the circumstances causing reversal and upon which line-shaft joint unscrew, there may be enough energy stored in the rotating parts, at the time the coupling clears the pins, to cause the pump shaft to continue to rise and strike the top cap. However, if the above conditions are met, damage, even in the most severe cases, should be limited to a broken top cover or fan.

It is intended that self-release couplings will be called upon to uncouple only infrequently.

NOTE: Any time a self-release coupling uncouples, it is necessary to remove all power and manually re-couple.

Un-coupling is most frequently caused by application of single-phase power after a power supply disturbance, while the motor is being driven in the reverse direction by the pump; this single-phase power causes the motor to take over and drive the pump in the reverse direction and the pump shaft joints will then unscrew. To prevent this, select a motor starter which requires a manual start after any stop (rather than allowing automatic re-start as soon as power is applied to the starter), or incorporates a back-spin timer to keep power from being automatically reapplied to the motor until enough time has elapsed for water back-flow through the pump to stop and for the motor to completely stop.

Power supply phase-sequence reversal will also cause the motor to reverse and unscrew the pump shaft, but this rarely occurs. An antiphase-reversal relay can be incorporated in the motor controller if desired.

To prevent un-coupling on initial start-up, check motor rotation direction before installing the upper half-coupling to be sure direction is correct. To reverse direction of rotation, interchange any two power leads.

3. <u>Bolted Couplings</u>

Bolted couplings allow up-thrust from the pump to be taken by the motor bearings. This type of coupling is similar to a self-release coupling except that the driving pins are replaced by bolts, which should be securely tightened to hold the two halves of the coupling solidly together so that torque is transmitted by face friction. See Torque Requirements. This type of coupling does not have the self-release feature and allows reverse rotation.

See the self-release coupling shown to the left of the motor center line in Figure 2, which is applicable to bolted couplings except that the headless drive pins are replaced by bolts as explained above.

To install a motor with a bolted coupling, first unbolt and remove the fan, thus exposing the coupling bolts. Then unbolt and remove the upper half-coupling. Next, lower the motor onto the pump with pump shaft through the motor shaft. Then set the upper half-coupling into place on the lower half-coupling and put the gib-key in place, tightening the bolts as shown on page ? Then put the pump nut in place, adjust the pump and lock the nut. Finally, put the fan in place on the upper half-coupling and secure it with the 3 capscrews provided.

4. Non-Reverse Couplings

Warning	***For explosion-proof motors, a special non-reverse end-shield cover made of bronze must be used, so pins striking ratchet teeth will not Spark.***

The non-reverse type of coupling, as shown to the right of the motor centerline in Figures 1 and 2, is also a bolted type, and, in addition, it keeps the pump and motor from rotating in the reverse direction. Thus, it not only prevents the pump shaft from unscrewing and damage to water-lubricated pump shaft bearings, when during shutdown the residual water in the system drives the pump in the reverse direction. This type of coupling also allows up-thrust from the pump to be carried by the motor bearings. Motor torque is transmitted to the pump shaft through the two halves of the coupling which are bolted together. See Required Bolt Torques.

To install a motor with a non-reverse coupling, first unbolt and remove the fan, thus exposing the coupling bolts. Next, put the fan bolts back in place to secure the pin-retaining plate to the pin-carrier and keep the non-reverse assembly from flying apart. Then, unbolt and remove the upper half-coupling and non-reverse assembly. Next, lower motor onto the pump with pump shaft through the motor shaft. Then set the upper half-coupling and non-reverse assembly into place on the lower half-coupling and bolt it to the lower half-coupling, tightening the bolts. Then install the gib-key and pump shaft nut, adjust the pump and lock the nut. Finally, remove the three small capscrews securing pin-retaining plate, put the fan in place and secure it with these same capscrews.

The operation of a non-reverse coupling is explained as follows. When the motor is started in the correct or forward direction, the ratchet pins are lifted by the ratchet teeth and are held up by centrifugal force and friction when motor speed becomes high enough. When power is removed, the speed decreases, and the pin will catch on a ratchet tooth and prevent backward rotation. The number of pins differs from the number of teeth to multiply the number of stopping positions.

A very rapid decrease in speed can result in acceleration forces great enough to prevent the pins from dropping. This condition is further aggravated when the pins become dirty and their action sluggish. If the time from shutdown (the instant the “stop” button is pressed) to zero speed is greater than two seconds, operation will be satisfactory.

To permit operation when stopping time is less than two seconds, the pins are spring-loaded. For those cases involving cycling (frequent starting and stopping) and stopping times greater than two seconds, the springs may be removed to decrease wear on the ratchet plate.

Pins and springs are made of heat-treated stainless steel.

A complete non-reverse coupling consists of a self-release coupling plus a non-reverse assembly, which includes pin carrier, pins, springs, pin retaining plate, and capscrews.

On motors covered by this instruction book, the ratchet teeth are an integral part of the Endshield cover casting.

A self-release or a bolted coupling can be converted to a non-reverse coupling on 324-405 frame motors without disturbing the adjustment of the pump shaft nut.

The non-reverse assembly will normally be received as a unit. To assemble it onto the motor, unbolt and remove the fan, thus exposing the coupling pins or bolts. Next, remove the drive-pins or bolts from the lower half-coupling. Next, insert the long capscrews through the plate, pin carrier, and top coupling. Tighten them securely so that torque will be transmitted by friction between the coupling faces rather than through the bolts. See TORQUE REQUIREMENTS. Next, remove the three smaller capscrews securing the pin-retaining plate to the pin-carrier. Finally, put the fan into place on top of the pin-retaining plate and secure it with the three capscrews just removed. On 213-286 frame machines, the pump shaft nut must be removed and the bolted or self-release coupling replaced with a non-reverse coupling.

The top half of the coupling should seat solidly on the lower half and the pins should touch the bottom of the pockets between the teeth in the ratchet. The clearance between the pin-carrier and the top of the ratchet teeth should be between 1/16” and 1/8”.

Warning

A non-reverse assembly must not be added to explosion-proof motors unless a bronze end-shield cover is also installed. This is to avoid sparking that might occur when the steel pins of the non-reverse assembly strike the endshield cover.

When installing a non-reverse coupling do not use lubricant. Lubrication will lower the coefficient of friction between pins and pin carrier, and the pins may not stay up when motor reaches full speed.

E. Power Supply and Connections

1. Wiring and Grounding

Warning

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.

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 ±10% of nameplate value or frequency within ±5%, and a combined variation not to exceed ±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.

F. Lubrication

Motors with oil-lubricated bearings (324-405 frames) are shipped without oil. Before starting the motor, fill each reservoir to the standstill level shown on the sight gage. Be careful to keep dirt out of the lubricant and bearing housing.

Use only the oil specified on the lubrication nameplate or the lubrication instruction supplied with each motor. See RELUBRICATION, Table II and LUBE NAMEPLATE for oil grade and viscosity and further instructions.

If reservoirs have had oil in them during storage period, drain out this old oil when installing the motor for operation.

IV. OPERATION

Caution

Before energizing the motor for the first time or after an extended shut-down, 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.

Warning

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

A. Steps Prior to Initial Start-Up After a Long Idle Period

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

Warning

Before measuring insulation resistance, the machine must be at stand-still 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.

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 95ºC to 115ºC. until the stator has been above 90ºC for at least four hours. Then the air temperature may be raised to 135ºC to 155ºC. 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 90ºC. Do not exceed this temperature. Maintain a temperature of 90ºC until the insulation resistance becomes constant for a one-half hour period.

2. Check bearing oil reservoirs to be sure they have been filled to the proper level with fresh oil. See RELUBRICATION, Table II and LUBE NAMEPLATE on motor for oil grade and viscosity and further instructions. Be sure filler caps and drain plugs are securely tightened.

3. Examine the motor for loose objects or debris which may have accumulated and remove any foreign material.

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

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

6. 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 pump. To run a VHS motor uncoupled, it is recommended that the pump head-shaft be removed. If this cannot be done, remove the upper half-coupling and be sure the pump shaft is well centered in the motor shaft so it will not rub. IF THIS IS DONE, ROTATE MOTOR BY HAND TO BE SURE THERE IS NO INTERFERENCE BETWEEN SHAFTS. Do not try to run motor un-coupled by just removing gib-key.

7. 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. On VHS motors, do this before installing pump head-shaft and upper half-coupling.

   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 deenergized 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

Warning

Repeated starts and/or jogs of induction motors greatly reduce the life of the winding insulation. The heat produced by each acceleration or jog 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.

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

Before initiating maintenance procedures, disconnect all power sources to the motor and accessories. 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. Replace all normal grounding connections prior to operating. Failure to observe these precautions may result in injury to personnel.

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 condition, 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 sealing 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

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 (except for bearings), it is recommended that the motor be sent to an authorized General Electric service shop. Minor repairs and routine maintenance can be done locally provided proper precautions are taken not to alter the original explosion or dust-ignition proof features. However, it should be emphasized that failure to observe these precautions may result in a motor which is unsafe for use in hazardous locations and such use may result in a serious explosion causing property damage, personal injury, or both.

Whenever it is necessary to disassemble one of these motors, it is essential that it first be disconnected from the supply circuit and removed from the hazardous area. All machined metal surfaces forming joints in the motor housing must be protected from damage. Hammers or prying tools should not be used where they come in contact with joint surfaces.

No clearance should be increased either at joints, around shaft, or between rotor and stator. No new openings should be made and changes that alter the strength of the parts must be avoided. Before reassembling the motor, carefully clean the joint surfaces and then apply a thin coating of Gredag 52 graphitized grease or other Underwriters Laboratories approved non-hardening material.

During assembly, carefully fit the parts together. All holding bolts and capscrews should be returned to their correct place, and properly tightened. Substitution of bolts or other parts should not be made. Bolts may be part of a flame cooling path, and maintenance of proper clearance between bolt and bolt hole is essential.

C. General Cleanliness

While TEFC and Explosion-Proof motors are enclosed for protection against adverse conditions of service, they should be kept reasonably clean for longer trouble-free life. External air passages in the top endshield and stator frame should be cleaned periodically to prevent overheating of the motor. 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.

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. Coupling Maintenance

The condition of non-reverse couplings should be checked periodically by removing the tip cap. If dirt has caused the action of the pins to become sluggish, the pin-carrier should be removed, disassembled, and thoroughly cleaned with a suitable solvent. The parts should then be dried and reassembled in accordance with the instructions given under NON-REVERSE COUPLINGS.

Sometimes, after a long period of operation with frequent stops and starts, the surface of the holes in the pin-carrier becomes polished, so that friction forces will no longer hold the pins clear of the ratchet teeth when the motor is running. This condition can be remedied by roughening these surfaces with a piece of emery paper wrapped around a rod.

NOTE: Whenever the dismantling of couplings is necessary, the use of witness marks will assure a balanced condition when reassembly is complete.

Bolts on both bolted couplings and non-reverse couplings should be checked periodically to be sure they are tight. See Recommended Tightening Torques.

E. Relubrication

1. Oil Lubricated Bearings

Motors 320 frame sizes and larger generally have an oil lubricated upper bearing. The following instructions apply to that bearing. Grease lubricated instructions for all other bearings are included in the following section.

Motors covered by these instructions have oil lubricated bearings. Maintain proper lubrication by checking the oil level periodically and adding oil when necessary. Because of the clearing action of the bearing as the motor accelerates up to speed and the expansion of the oil as it comes up to operating temperature, the oil level will be higher after the motor has been in operation for a while than it is with the motor at standstill. The normal level, with the motor stopped and the oil cold, is marked STANDSTILL LEVEL on the sight gage.

Overfilling should be avoided not only because of the possibility that expansion may force the oil over the oil sleeve and into the motor, but also because operating with the oil level too high prevents the bearing from clearing itself of excess oil. The resultant churning can cause extra loss, high temperatures, and oxidized oil. If, during operation, the oil level goes above the maximum shown on the sight gage, drain enough oil to bring the level back within the operating range. A hole is provided inside the drain plug to make it possible to do this without completely removing the plug.

Do not permit the operating oil level to fall below the minimum shown on the gage. Should it ever become necessary to add excessive amounts of make-up oil. investigate immediately for oil leaks.

Table II

OIL VISCOSITY (For a particular motor, refer to the lubrication nameplate or instructions)				
Bearing Function and location	Bearing Type	Oil Viscosity @ 100ºF	SUS @ F	GE Spec.
Thrust Bearing (In top endshield) 320-405 Frame	Angular Contact Ball	150	45	D6B6A
Guide Bearing (In base endshield) 405 frame, 3600 rmp only – others are grease lubricated	Ball	150	45	D6B6A

Change oil at regular intervals. The time between oil changes depends upon the severity of operating conditions and, hence, must be determined by the motor user. One or two changes a year is average, but special conditions, such as high ambient temperature, may require more frequent changes. Avoid operating motor with oxidized oil.

Use only best grade, oxidation and corrosion inhibited turbine oil produced by reputable oil companies. The viscosity (weight) of the oil to be used depends upon the type and size of the bearing, its load and speed, the ambient temperature, and the amount and temperature of the cooling water (if used). The lubrication nameplate or instruction with each motor specifies the viscosity range of oil suitable for average conditions. The usual recommendations are summarized in Table II, Oil Viscosity. Operation in ambient temperatures that are near or below freezing may require preheating the oil or the use of a special oil.

In some cases, water cooling for the oil is impractical or undesirable and the normal operating oil temperature will be in range of 170º to 210ºF. Also, in some cases, the bearing size, thrust-load and speed are so high that even with water cooling the normal oil temperature may be as high as 210ºF. In these cases, it is especially important that proper viscosity, high-grade oil containing an oxidation inhibitor be used. Observe the condition of the oil frequently and change oil when it begins to show signs of deterioration.

Oil-lubricated bearing housings are provided with large settling chambers in which dust, dirt, and sludge collect. Unless the oil has been permitted to oxidize, the draining of the old oil during regular changes will usually provide sufficient flushing action to clean out the reservoir.

Whenever the motor is disassembled for general cleaning and reconditioning, the bearing housing may be washed out with a suitable cleaning solvent. 1,1,1, Trichloroethane may be used, following the same instructions and cautions as shown for cleaning windings. Avoid using any solvent that will soften the paint used on the interior of the oil reservoir. Be sure that the oil metering hole is clear, and then dry the housing thoroughly before reassembly.

2. Grease Lubricated Bearings

The thrust bearing on 182-286 (bottom bearing) and the guide bearing on the 182-405 frame (182-286 top bearing and 324-405 top bearing) are generally grease lubricated. The thrust bearings of motors with speeds above 1800 RPM should be regreased every 1000 hours of operation with an 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 6 months. The guide bearings should be regreased in accordance with attached schedule.

Type Service	Typical Examples	Relubrication Interval
Easy	Infrequent operation	1 year
Standard	One or two shift operation	6 months
Severe	Continuous Operation	3 months
Very Severe	Dirty locations and/ or high ambient temperatures	2 months

Relubrication should be with General Electric D6A2C5 grease for best results unless special grease is specified on the nameplate.

The following procedure should be used in regreasing:

a. Stop the unit.

b. Disconnect unit from the power supply.

c. Remove the relief plug and free the hole of hardened grease.

d. Wipe the lubrication fitting clean and add grease with a hand-operated gun..

e. Leave the relief plug temporarily off. Reconnect the unit and run for about 20 minutes to expel the excess grease.

f. Stop the unit; replace the plug.

g. Restart the unit.

Caution	***Failure to observe the foregoing instructions for regreasing may result in grease leakage and/or bearing damage.***

F. End-Play Adjustment

1. General

Most high-thrust motors are designed to withstand only momentary up-thrust. This up-thrust, which can exist for a few seconds during starting, is taken by the guide bearing. To prevent the thrust bearing from losing radial stability during this time, the motor endplay is limited to a small amount by adjustment of the motor shaft nut or by shimming. This adjustment is made at the factory

and need not be disturbed on a new motor. However, should the motor be diassembled for any reason, the adjustment must be made during reassembly to avoid damaging the bearings or having some rotating part rub against a stationary part. The procedure depends upon the type of thrust bearing.

2. Lower Thrust Bearings – 182-286 Frames, Grease Lubricated

Standard high-thrust motors are designed to withstand only momentary up-thrust. This up-thrust which can exist for a few seconds during starting, is taken by the guide bearing. To prevent the thrust bearing from losing radial stability during this time, the motor end play is limited to a few thousandths of an inch by shims inserted in the housing above the upper bearing. This adjustment is made at the factory and need not be disturbed on a new motor. However, should the motor be disassembled for any reason, the adjustment must be made upon reassembly to avoid damaging the bearings.

Whenever these motors are reassembled, the shims should be replaced and the end play checked to see that it falls within the allowable 0.005 to 0.007”. See Figures 1 and 3.

Motors which must withstand continuous up-thrust have a somewhat different construction. The thrust bearing is arranged to take this up-thrust and is clamped in the bearing housing. No shims are used in these motors since the lower bearing is of the type which can withstand axial load in both directions. See Figure 3A.

3. Upper Ball Thrust Bearing

324-405 Frames,
Oil Lubricated

For a motor with angular-contact ball thrust bearings, refer to Figures 2 and 4. When the motor shaft nut is tightened, the rotor, shaft and lower bearing are drawn up until the outer ring of the lower bearing seats against the lower bearing cover. Further tightening of the nut preloads the bearings. (Note that the shoulder on the shaft below the lower half-coupling is purposely located so that it does not seat against the coupling.)

The best way to adjust the nut is by trial, using an indicator between the lower half-coupling and top endshield, and lifting the rotor to check the end-play after each setting of the nut until between 0.002” and 0.005” is obtained. The nut should then be locked with its lockwasher. If equipment is not available to use this method, the following procedure may be used. Tighten the motor shaft nut carefully until all end-play is removed and the rotor just fails to turn freely. Then back the nut off 1/6 turn and lock with its washer. An assembly nameplate giving this information is mounted on the motor.

Motors which must withstand continuous up-thrust have a somewhat different construction. The upper (thrust) bearing is arranged to take this up-thrust; it consists of angular-contact thrust bearings mounted back-to-back (DB). (See Figure 4A). The inner rings are locked on the lower half-coupling with a nut and the outer rings are clamped in the endshield with a ring. The shaft shoulder below the lower half-coupling is so located that it seats against the lower half-coupling before the lower bearing comes up against its cover. No special adjustment is necessary when reassembling this type of motor, and the motor shaft nut can be pulled down tight and locked. The end play of the motors using DB-mounted bearings will then be very small, 0.005” or less.

G. Bearing Replacement

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

When removing bearings, apply steady, even pressure parallel to the shaft or lower half coupling center line. Apply this pressure to the inner race whenever possible. Angular-contact bearings which have failed and are especially tight on the coupling, can sometimes be removed by using the following procedure: separate the bearing by forcing the outer race over the balls; then, with a torch, apply quick heat to the inner race while also applying pulling pressure.

Angular-contact bearings which are to be stacked together should have their high points of eccentricity (indicated by a burnished spot on the inner race) lined up. All bearings should be of the same manufacturer and of the type that permits stacking.

Some motors with angular-contact ball bearings are supplied with removable spacer rings under the outer race of the thrust bearing so that the thrust capacity can be increased by adding an extra bearing or bearings. When these bearings are installed, the high points of eccentricity should be lined up with the keyway in the lower half-coupling. If the original bearings have been in service, they should be replaced at the time this conversion is made.

H. 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 precede 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 from windings to avoid driving 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 309 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.

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.

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.

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.

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

VI. 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.

VII. TROUBLE SHOOTING CHART

Affected Parts	Difficulty	What to Check
Windings	Overheating	• 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	• Calibration of measuring instrument • Worn out or dirty oil • Insufficient Oil • Misalignment • Excessive thrust or radial loading • Shaft currents • Improper end-play • Fan broken
Bearing Housing	Oil Leaks	• Incorrect grade of oil (type or viscosity) • Loose fittings • Cracked/porous casting • Over-filled • Water in oil
Motor	Excessive Vibration	• 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	• 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	• 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

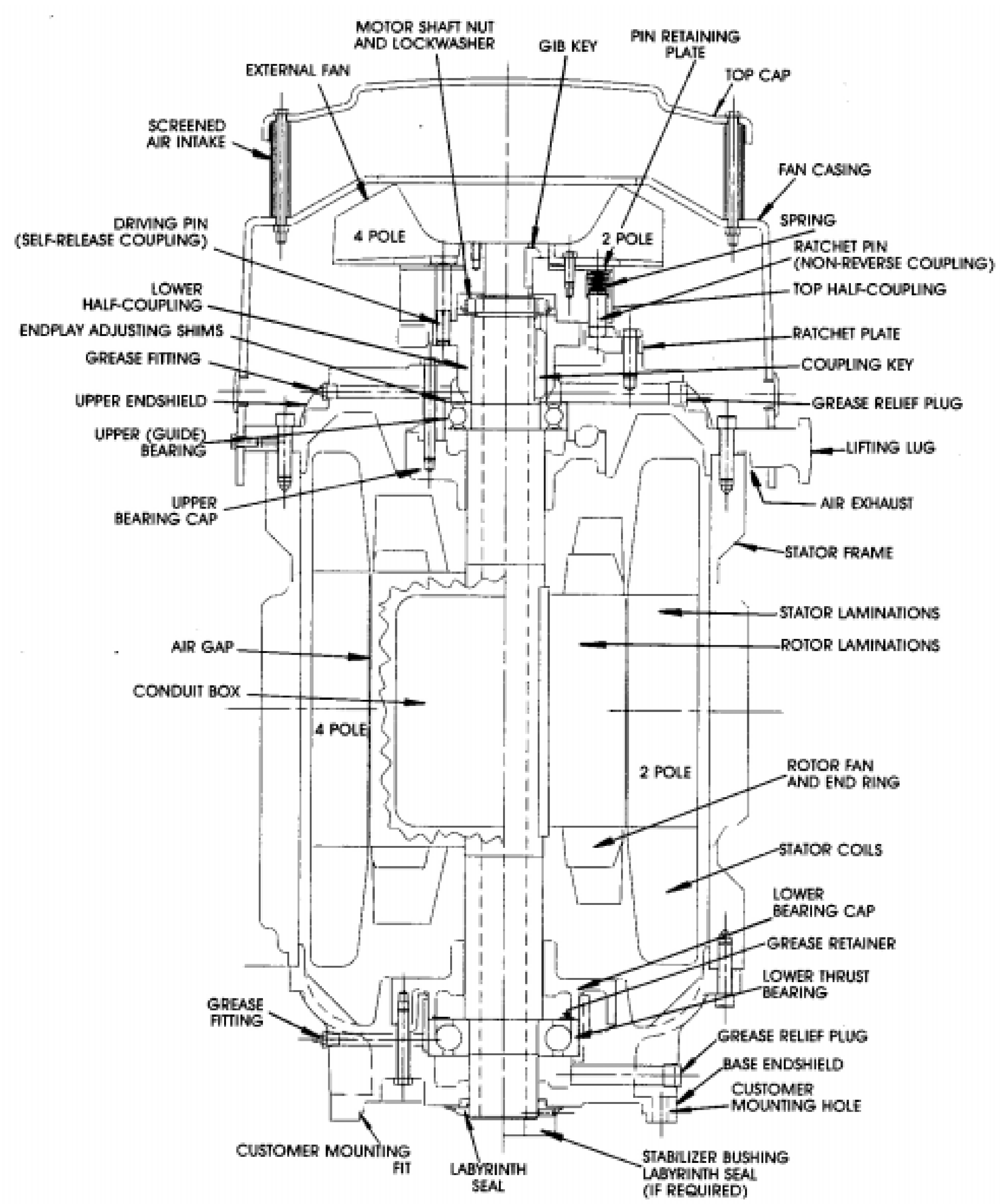

Figure 1 — 213-286 Frame Motors

Typical Hollow-Shaft High-Thrust,
Totally Enclosed Fan Cooled Or Explosion-Proof Motor
With Angular Contact Ball Lower Thrust Bearing

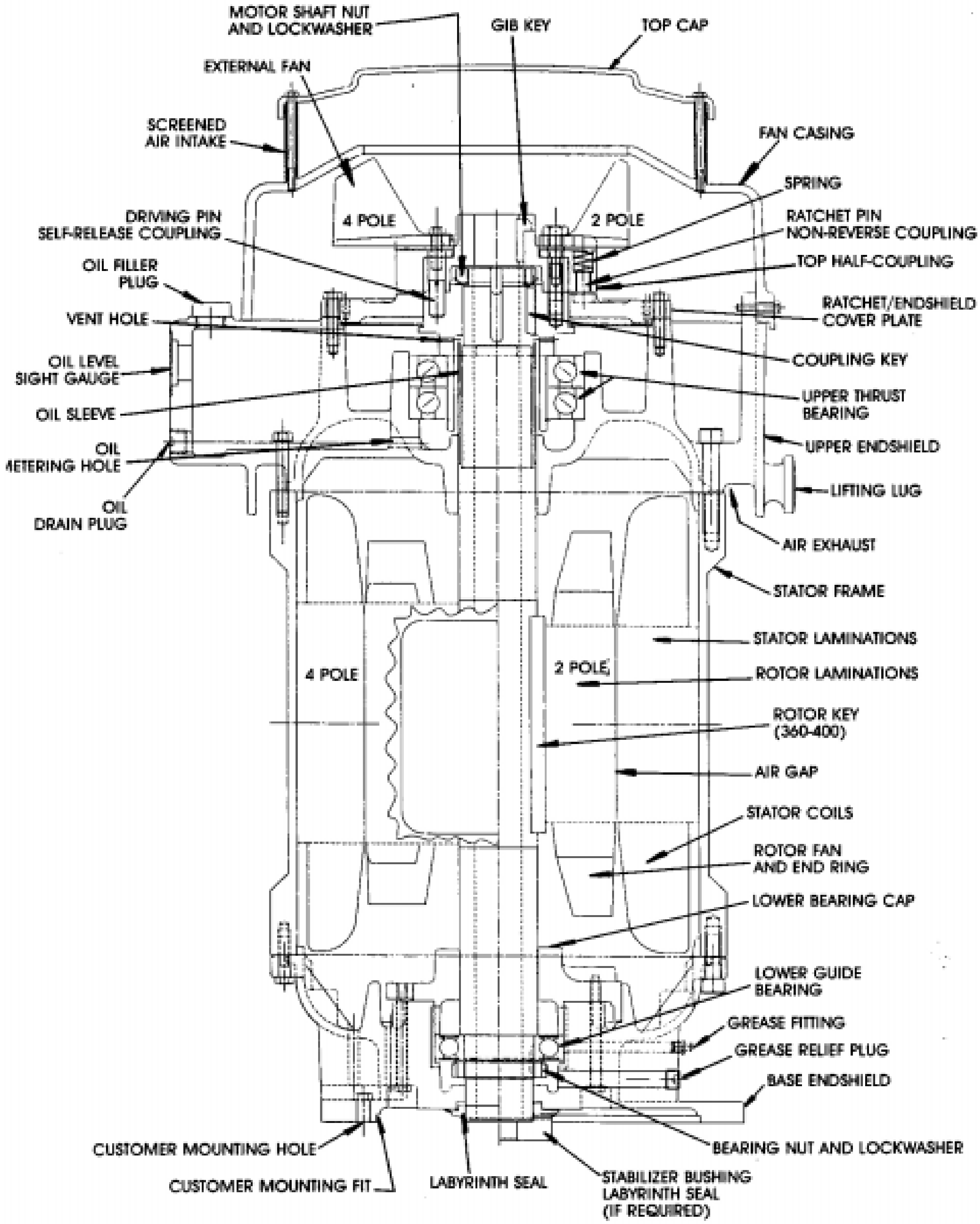

Figure 2 — 324-405 Frame Motors

Typical Hollow-Shaft High-Thrust,
Totally Enclosed Fan Cooled Or Explosion-Proof Motor
With Angular Contact Upper Bearing.

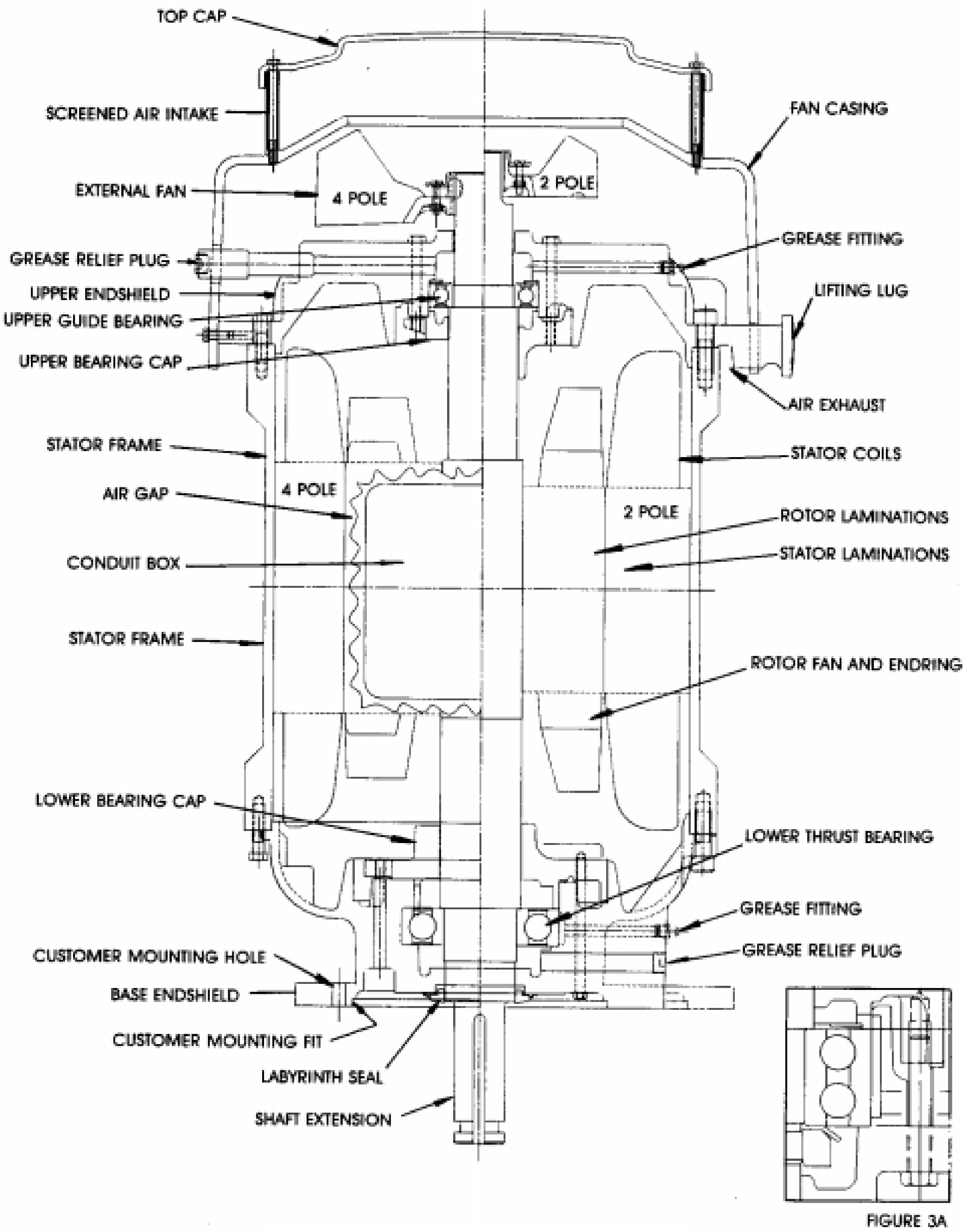

Figure 3 — 182-286 Frame Motors

Typical Solid Shaft High-Thrust, Totally Enclosed Fan Cooled Or Explosion-Proof Motor With Angular Contact Lower Bearing. Typical Solid Shaft Construction For Continuous Up And Down Thrust Is Shown In Figure 3A.

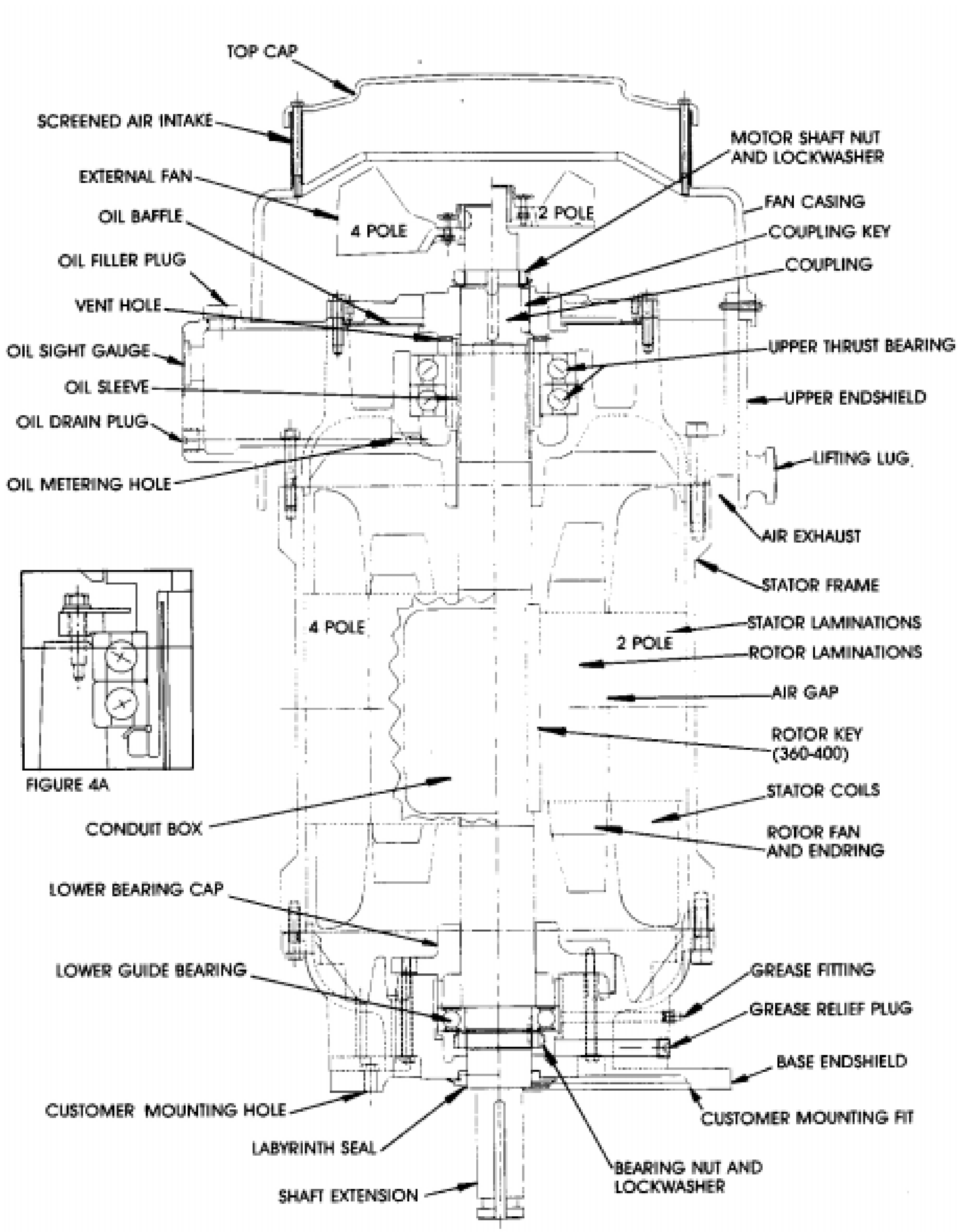

Figure 4 — 324-405 Frame Motors

Typical Upper Bearing And Fan Construction For TEFC And Explosion-Proof Solid Shaft Motors Suitable For High Down Thrust, Momentary Up-Thrust And Limited Endplay. Typical Solid Shaft And Inline Pump Motor Construction For Continuous Up And Down Thrust Are Shown In Figure 4A.

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