



GE Industrial Systems

Instructions

Vertical Induction Motors

High Thrust

Hollow and Solid-Shaft

In-Line Solid-Shaft

Frames 182-405 NEMA Type P Base

Weather Protected Type I

SAFETY PRECAUTIONS



Warning

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.

Table of Contents

<u>Subject</u>	<u>Page</u>
Safety Warnings.....	2
Introduction	4
Receiving, Handling, and Storage.....	5
Unpacking	5
Installation	5
Location and Mounting	6
Pump and System Precautions	6
Alignment of Solid Shaft Motors	6
Couplings for Hollow-Shaft Motors.....	6
Self Release Couplings.....	7
Bolted Couplings	9
Non-Reverse Couplings	9
Power Supply and Connections	10
Wiring and Grounding.....	10
Allowable Voltage Frequency	10
Position of the Conduit Box.....	11
Lubrication.....	11
Operation	11
Steps Prior to Initial Startup	11
Initial Startup	13
Jogging and Repeat Starts	14
Maintenance	14
General.....	14
General Cleanliness.....	15
Coupling Maintenance	15
Relubrication.....	15
Oil Lubricated Bearings	15
Grease Lubricated Bearings	16
End-Play Adjustment	18
General	18
Lower Thrust Bearings – 182-286 Frames, Grease Lubricated.....	18
Ball Thrust Bearings – 320-405 Frames, Oil Lubricated.....	18
Bearing Replacement.....	19
Insulation and Winding Maintenance.....	20
General.....	20
Vacuum and Compressed Air Cleaning	20
Cleaning with Water and Detergent.....	20
Cleaning with Solvents.....	21
Re-Varnishing Windings	21
Renewal Parts	21
Trouble Shooting Chart.....	22

VERTICAL INDUCTION MOTORS HIGH THRUST HOLLOW AND SOLID-SHAFT IN-LINE SOLID-SHAFT FRAMES 182-405 NEMA TYPE P BASE WEATHER PROTECTED TYPE I

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 and solid-shaft is available in 182 and larger frames. Figure 1 shows a typical 213-286 frame hollow-shaft motor and Figure 2 shows the 324-405 frame construction. The solid-shaft construction is similar except that the top half-coupling is omitted, and the motor shaft extends out the bottom of the motor. See Figures 3 and 4. 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 capacity of a high-thrust motor. NOTE THAT ANGULAR-CONTACT BEARINGS CAN ONLY CARRY THRUST IN ONE DIRECTION.

IN-LINE motors are designed to be mounted on pumps which are directly in the pipe-line and are also covered by this instruction book. These motors have two opposed-mounted angular-contact ball thrust bearings at the top end of the motor (182-286 bearings are in bottom end of the motor (182-286 bearings are in bottom end) so they can carry either up or down thrust. The lower guide bearing is a radial-ball type and also carries any radial load imposed by the pump. IN-LINE motors are always of the solid-shaft type.


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

This instruction book applies to motors with Weather-Protected I enclosures as defined by NEMA. These are "open" motors.

Weather-Protected I motor construction is shown in Figures 1 and 2 for hollow-shaft motors and Figures 3 and 4 for solid-shaft machines.

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.

 <p>Warning</p>	<p><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</i></p>
<p><i>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></p>	

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 re-fill 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 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 the 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

 <p>Warning</p>	<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</i></p>
<p><i>installed as needed to protect against accidental contact with moving parts. Machines accessible to personnel should be further guarded by screening, guard rails 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>	

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 bolts securely.

Weather-Protected Type I motors may be installed in indoor locations with relatively high moisture content or sheltered outdoor locations in dry climates.



Warning

If ignitable dust or lint is present, the surface temperature of space heaters, if supplied, should not exceed 80% of the ignition tempera-

ture. 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.



Warning

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 of 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% 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

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 cap for access to the coupling.

Two slots are provided in the outside rim of the couplings so that a bar can be inserted to keep the assembly from turning while the adjustment is being made. A coupling bolt can be screwed into one of the extra tapped holes in the top end-shield 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.
3/8	20 lb. ft.
5/16	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 the coupling comes mounted in the motor failure to comply may cause the coupling bolts to break with resultant extensive damage to the equipment.

1. Self-Release Couplings

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 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 upper half of the self-release coupling is lifted up 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 THAT SELF-RELEASE COUPLINGS CANNOT CARRY UP-THRUST.

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 drive the pump line-shaft and the joints 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 prints shows a maximum dimension "XH" from the tip 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 1.

Table 1

Frame Size	XH
254-256	2.25"
284-286	2.50"
324-326	3.75"
364-365	3.75"
404-405	4.00"

Depending upon the circumstances causing reversal and upon which line-shaft joint unscrews, 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.

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

NOTE: ANYTIME 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 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 anti-phase-reversal relay can be incorporated in the motor controller if desired.

To prevent un-coupling on initial start-up, check motor stalling the upper half-correct. To reverse direction of rotation, interchange any two power leads.

2. Bolted Couplings

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 together so that torque is transmitted by face friction. See torque requirements on page 6. 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 centerline in Figure 2 which is applicable to bolted couplings except that the headless drive pins are replaced by bolts as explained above.

3. Non-Reverse Couplings

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 damage from overspeeding 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.

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 pins fall. At the instant of reversal, a 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 cap-screws. 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 326-405 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, loosen the three small cap screws that hold the pin-retaining plate so this plate can be centered during assembly. Next, remove the drive-pins or bolts from the lower half coupling. Then slide the non-reverse assembly down over the tip half-coupling. Next, insert the long cap screws through the plate, pin carrier, and top coupling and into the lower coupling. Tighten them securely so that torque will be transmitted by friction between the coupling faces rather than through the bolts. See torque requirements. Finally tighten the three small cap screws to secure the pin-retaining plate. 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".

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.

Motors shipped from stock may have their top couplings and non-reverse assemblies packaged separately. They can be installed as described in previous paragraphs.

E. Power Supply and Connections

1. Wiring and Grounding

 <p>Warning</p>	<p><i>Motor and control wiring, over-load 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></p>
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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-lad 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 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.


F. Lubrication


Motors with oil-lubricated bearings (324-405 frames) are shipped without oil. Before starting the motor, fill each reservoir to the stand-still 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 instructions supplied with each motor. See relubrication and Table II and lube nameplate for oil grade and viscosity and further instructions.

If reservoirs have had no oil in them during storage period, drain out this old oil and refill reservoir with fresh oil when installing the motor for operation.


V. OPERATION

 Caution	<p><i>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.</i></p>
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 Warning	<p><i>Be sure that the motor is not running and the power supply is disconnected before working on motor.</i></p>
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A. Steps Prior to Initial Start-Up After a Long Idle Period

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

 Warning	<p><i>Before measuring insulation resistance, the machine must be at stand-still and all windings to be tested must be electrically connected</i></p> <p><i>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.</i></p>
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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. Check bearing oil reservoirs to be sure they have been filled to the proper level with fresh oil. See relubrication and 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. Whenever possible, examine the interior of the machine 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 headshaft 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 uncoupled by just removing gibkey.


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 headshaft 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

	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.
Caution	

7. 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

	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.
Warning	

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. 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 compressed air lines and the danger of blowing metal chips into the insulation with compressed air.

 <p>Warning</p>	<p><i>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.</i></p>
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Screens and covers are provided as necessary for protection of the equipment and personnel. All screens must be kept free of dirt and debris to ensure proper ventilation, and kept in place for protection of personnel.

C. 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.

D. Relubrication

1. Oil Lubricated Bearings

Motors 320 frame size and larger have an oil lubricated upper bearing. The following instructions apply to that bearing. Grease lubricated instructions for all other bearings are included in the next 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 cleaning 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 for all oil leaks.

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 specified the viscosity range of oil suitable for average conditions. The unusual 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.

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 bottom 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

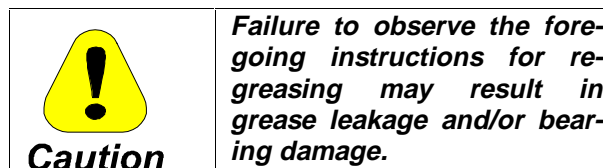
not to exceed three months. For motors with speeds 1800 RPM and below, regrease every 2000 hours of operation with the interval not to exceed 6 months. The guide bearings should be regreased in accordance with attached schedule.

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



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

In some cases, water cooling for the oil is impractical or undesirable and the normal operating oil temperature will be in range of 170°F to 210°F. 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 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.

Table II – Oil Viscosity

(For a particular motor, refer to the lubrication nameplate or instructions.)

Bearing Function and Location	Bearing Type	Oil Viscosity – SUS		
		@100° F	@210°F	GE Spec
Thrust Bearing (in top endshield 320-450 Frame)	Angular Contact Ball	150	45	D6B6A

E. 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 disassembled 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 that 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. Ball Thrust Bearing – 320-405 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 seats against the lower bearing cover. Further tightening of the nut preloads the bearings. (Note that 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 reassem

bling 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.

F. 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 or lower half-coupling centerline. 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.

driving particles into the windings and damaging the coils.

G. 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/or 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.

 <p>Warning</p>	<p><i>To prevent injury to eyes and respiratory organs, safety glasses and suitable ventilation or other protective equipment should be used.</i></p>
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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

 <p>Caution</p>	<p><i>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.</i></p>
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 <p>Warning</p>	<p><i>Operator must not use compressed air to remove dirt or dust from his person or clothing.</i></p>
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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).

 <p>Warning</p>	<p><i>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.</i></p>
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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

 <p>Warning</p>	<p><i>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.</i></p>
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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.

 <p>Warning</p>	<p><i>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.</i></p>
---	---

Windings cleaned with solvent should be dried thoroughly by circulation of dry air before voltage is applied.

5. Re-Varnishing 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.

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 • Improper end-play • 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

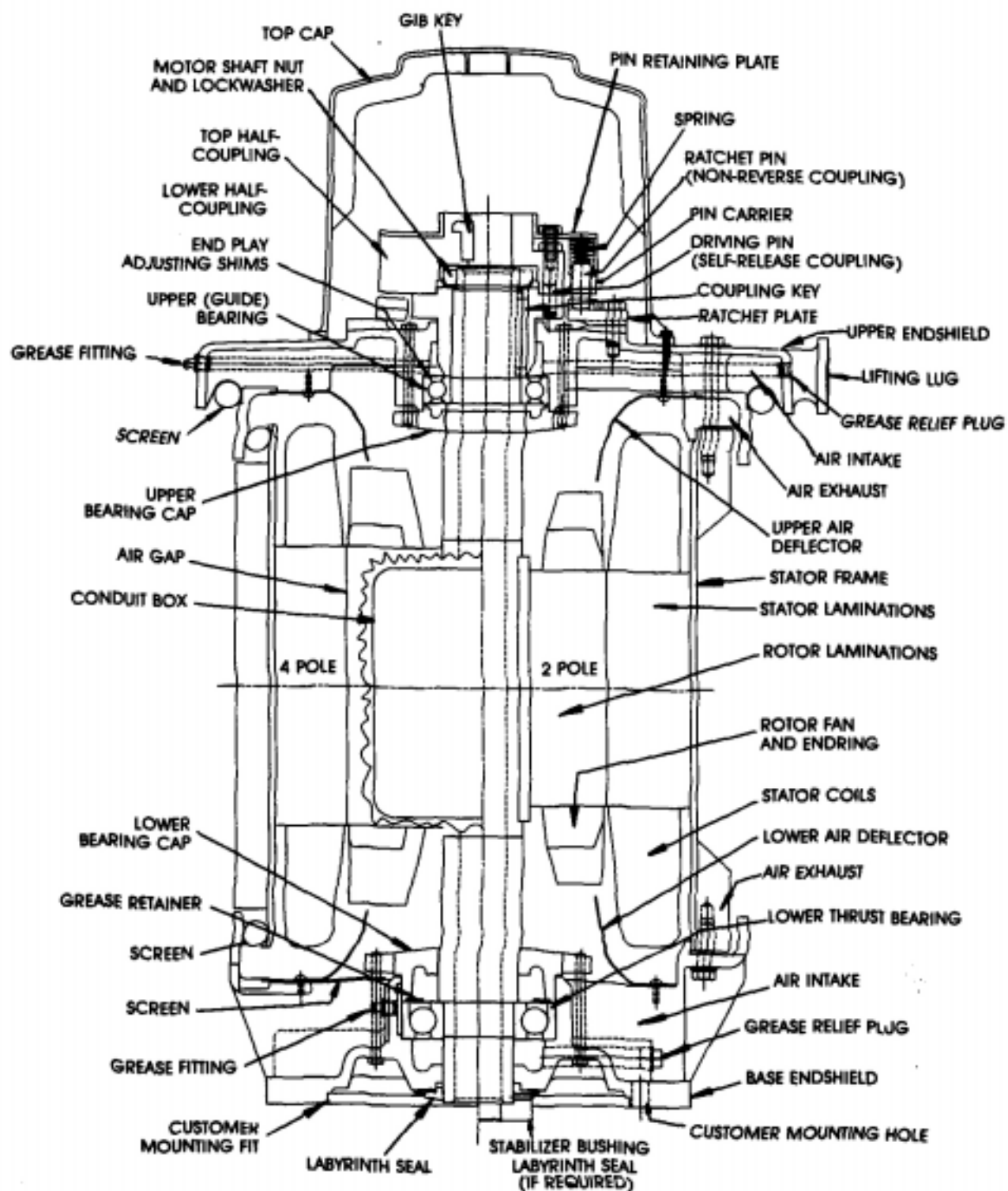


Figure 1 - 213-286 Frame Motors

Typical Hollow Shaft High-Thrust
Weather-Protected 1 Motor With
Angular-Contact Ball Lower Thrust Bearing

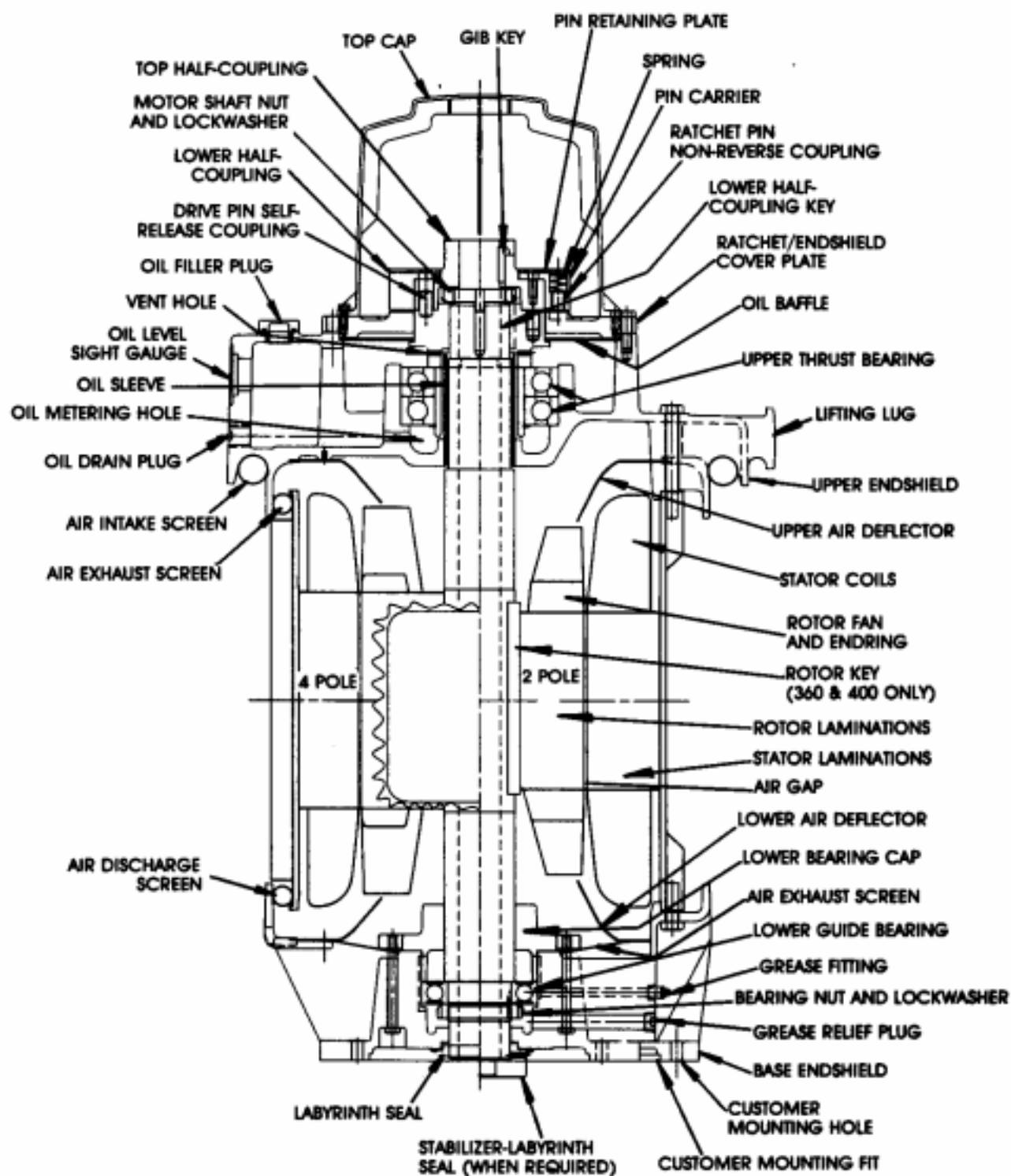


Figure 2 – 324-405 Frame Motors

Typical Hollow Shaft High-Thrust Weather-Protected 1 Motor
With Angular-Contact Ball Upper Thrust Bearing

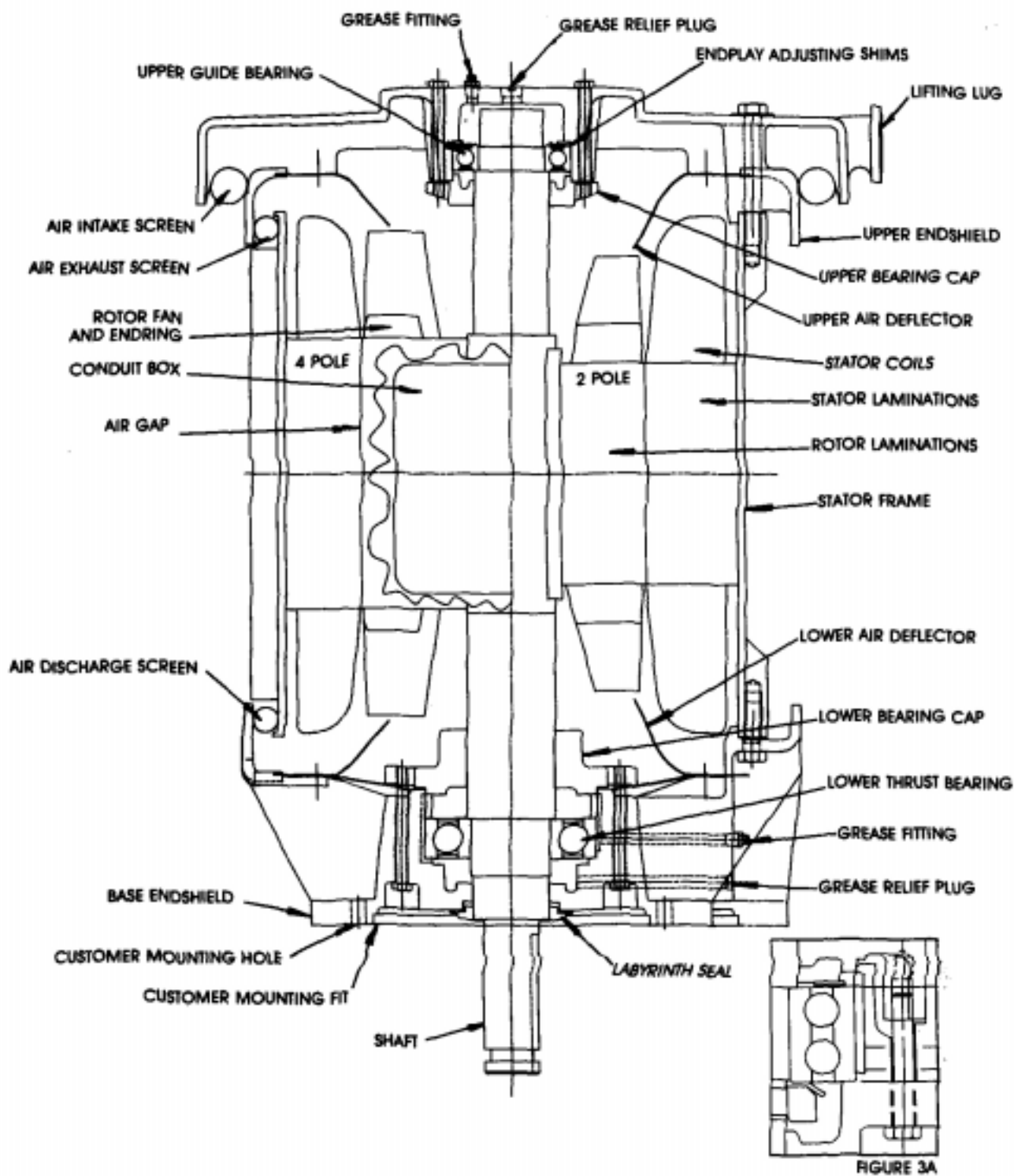


Figure 3 – 182-286 Frame Motors

Typical Solid Shaft High-Thrust Weather-Protected I Motor With Angular Contact Lower Bearing. Typical Solid Shaft Construction For Continuous Up And Down Thrust Is Shown In Figure 3A.



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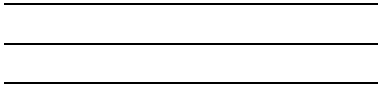
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