MAINTENANCE INSTRUCTION

M. I. 3308 - Revision B

CA SERIES ALTERNATORS
RUNNING MAINTENANCE
AND
OVERHAUL INSTRUCTIONS

Service Department
ELECTRO-MOTIVE DIVISION
GENERAL MOTORS CORPORATION
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SAFETY PRECAUTIONS

Please refer to the EMD Safety Precautions in appendix to the Locomotive Service Manual whenever routine service or maintenance work is to be performed on any AC traction equipped locomotive.

The maintenance procedure as outlined in this instruction is specific to CA Type Alternators and is offered for planning purposes only. As written, this document reflects current EMD product design and service experience for this design. The content of this M.I. reflects maintenance requirements based on time from delivery or miles in service. This recommendation is consistent with present fleet performance and remains within the EMD experience envelope.

This Maintenance Instruction is intended to serve as a guide when establishing maintenance schedules to meet the particular requirements of individual operations and planned economic life of the CA Series companion alternator. It provides average recommendations, which should ensure satisfactory locomotive operation, and economical maintenance costs where average load factors and climatic conditions are encountered.

The scheduled inspection and maintenance items defined herein are specific to the CA Series Companion Alternators. Component renewal provisions are consistent with traditional overhaul procedures.

For planning purposes, EMD has established the following overhaul interval recommendations for the Companion Alternator. These overhaul interval recommendations are based on whichever event occurs first: time, miles, or megawatt hours.

CA Series Companion Alternators:

- High Speed Service: 8 years / 1,000,000 miles.
- Heavy Haul Service: 8 years / 750,000 miles.

Note:

Mileage values referenced above are defined by Microprocessor Archive Data as accumulated by the locomotive control computer system.

As always, when specific operating conditions severely impact locomotive performance and or reliability, maintenance schedules must be adjusted accordingly.

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1.0 DESCRIPTION

The CA Series alternator is physically connected to, but electrically independent of, the main generator, Fig. 1. The CA rotor (field) is excited through a pair of slip rings adjacent to the slip rings for the main generator.

There are no controls in the CA excitation circuit; thus the alternator will be excited and developing power whenever the diesel engine is running. Output voltage will vary with speed of rotation, alternator temperature, and load.

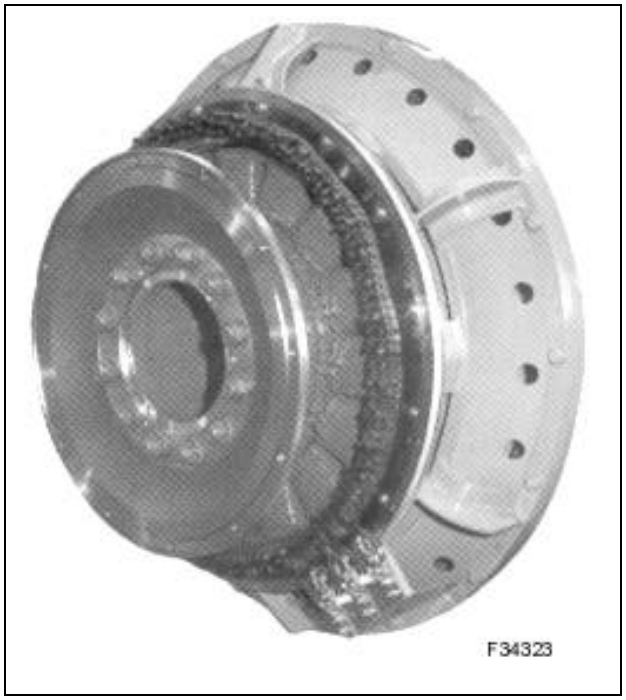

Fig. 1 – Typical Companion Alternator (CA5 shown)

The CA Series alternator is a variable frequency, variable voltage, rotating field, stationary armature, three phase, delta connected AC machine. The CA and main generator rotating assembly is directly coupled to the crankshaft of the diesel engine. Refer to the Service Data Section at the rear of this Maintenance Instruction for output ratings (Table 1).

The CA alternator provides power for auxiliaries (where equipped) such as the inertial filter blower motor, radiator blower motor, traction motor blower motor, generator blower motor, motor driven air compressor motor and also provides power for excitation of the main generator and for various control circuits. CA5, 6,7 models have one set of phase leads (1-2-3).

CA8 models have two sets of phase leads with 1-2-3 used for AC electrical equipment and 4-5-6 used for Traction Alternator excitation.

The CA9 models are equipped with three sets of phase leads with 1-2-3 used for AC electrical equipment, 4-5-6 used for Traction Alternator excitation and 7-8-9 used for APC 74-volt system (eliminates auxiliary generator).

The CA type alternator can be used with either an AC or DC generator. The most apparent differences in the application of the alternator to an AC or DC generator are in the collector ring assemblies. Collector ring size and number differ, Fig. 2 and 3.

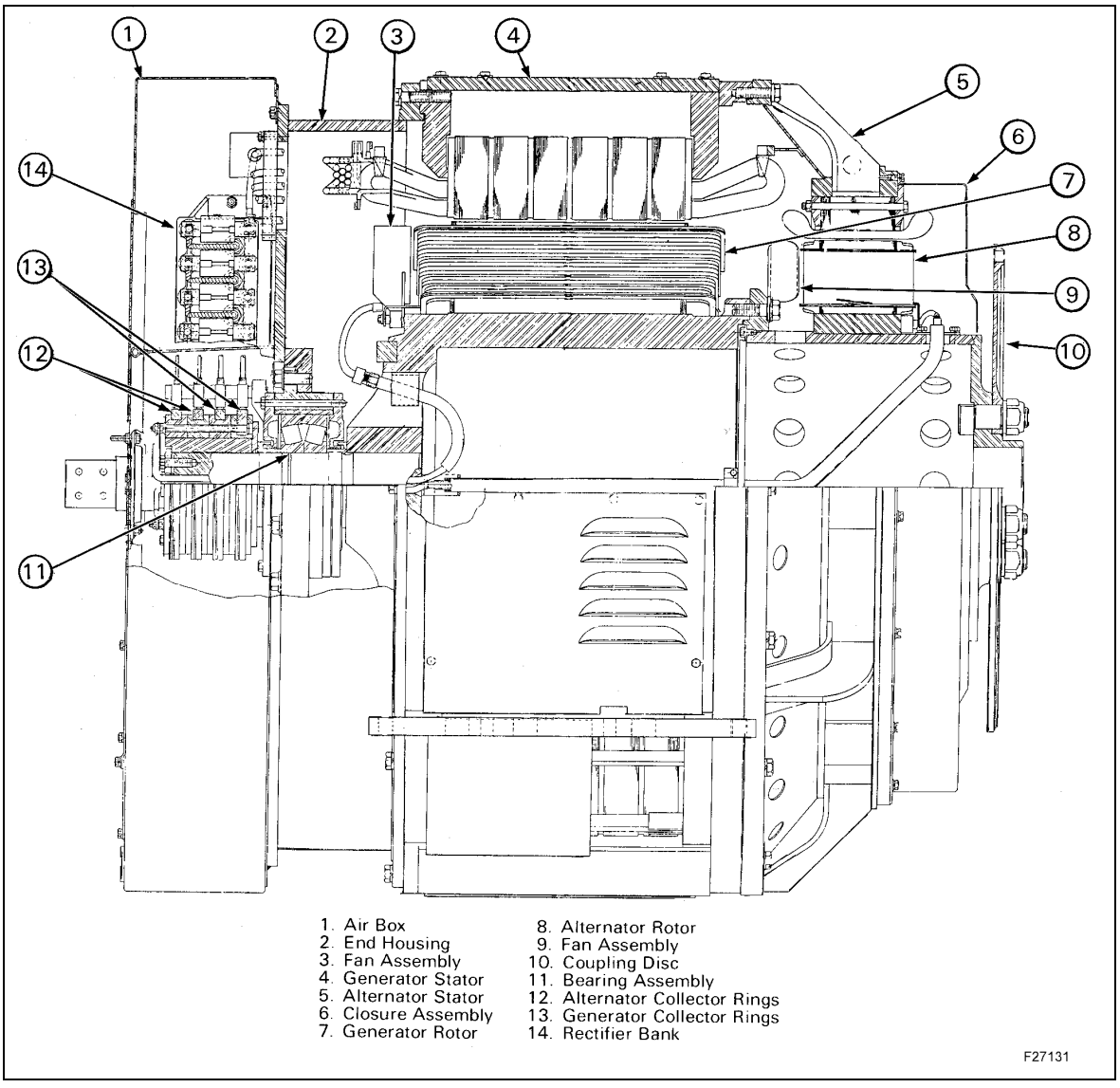

Fig. 2 – Typical AC Generator / Companion Alternator Assembly, Cross-Section

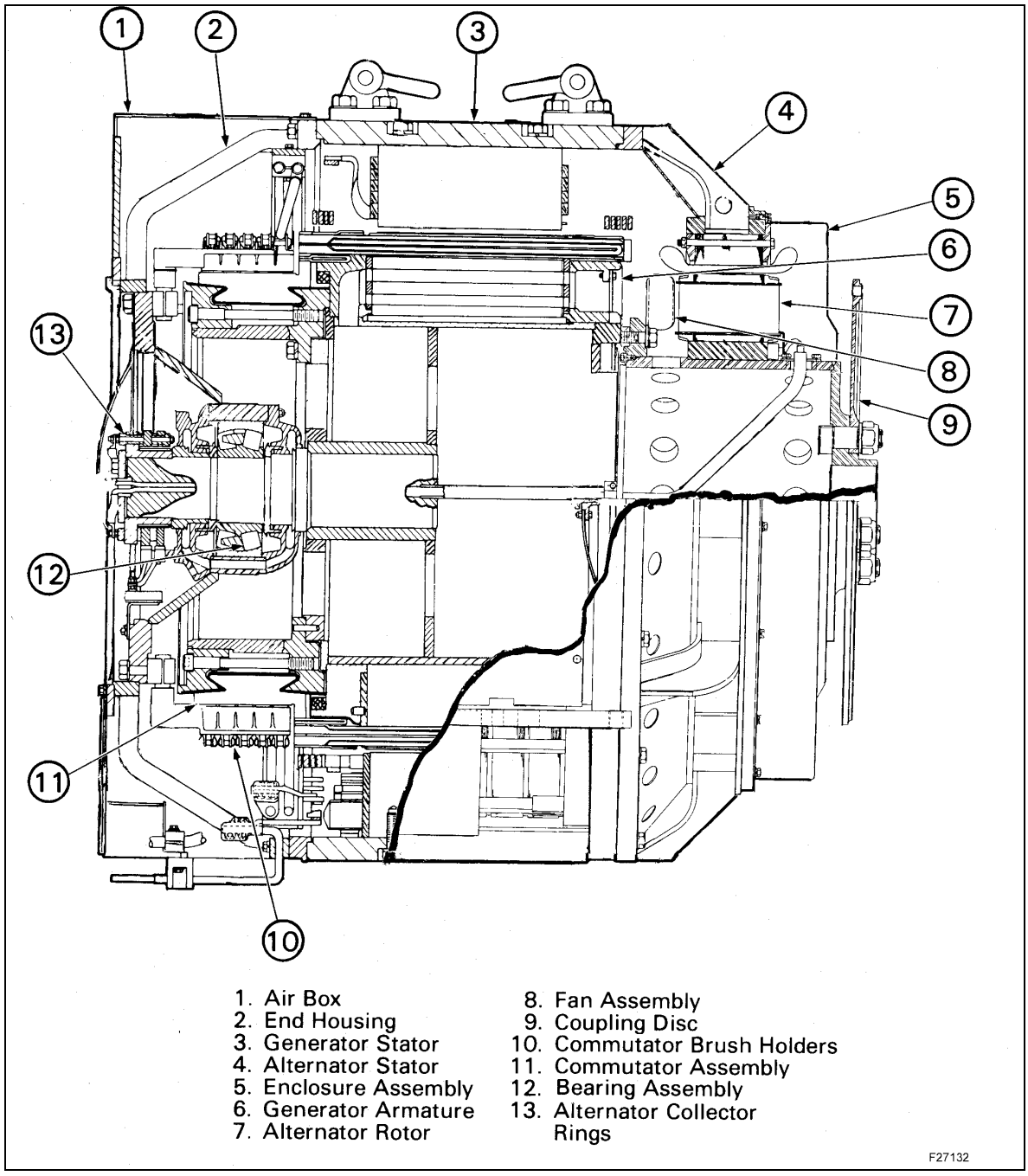

Fig. 3 – Typical DC Generator/CA Alternator Assembly, Cross-Section

Four 279.4-mm (11”) collector rings sharing a common assembly are used on the AC generator application. Main generator excitation is accomplished through the two inboard rings (#3 & #4); and companion alternator excitation is supplied through the two outboard rings (#1 & #2).

The DC main generator application has only two collector rings and associated equipment to provide excitation to the alternator. The collector rings are approximately 236.54 mm (9 – 5/16”). Excitation to the DC generator is provided through the commutator and commutator brush assembly.

1.1 OPERATION

The alternator stator assembly is bolted directly to the main generator frame. The rotor or rotating field assembly is bolted at one end to the main generator field assembly, and to the engine at the other end by means of a disc type coupling. Refer to Figure 4.

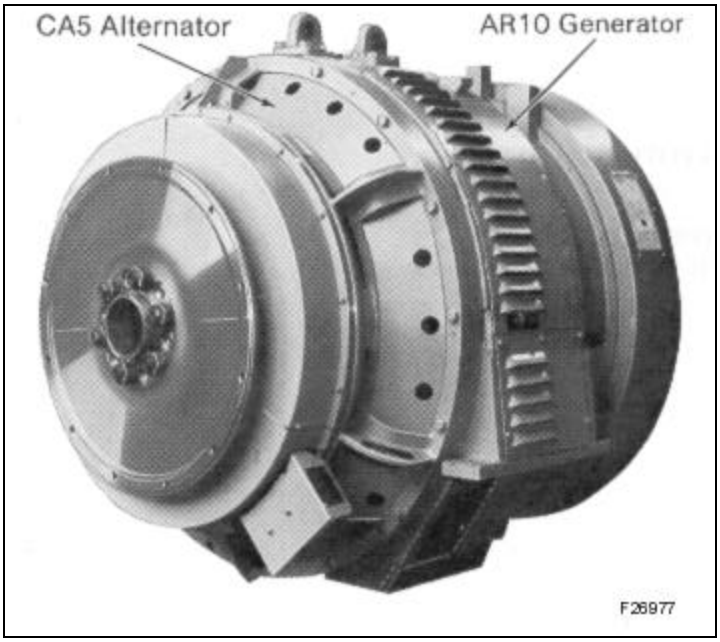

Fig. 4 – AC Generator/ Companion Alternator Assembly (AR10/CA5 shown)

The alternator field circuit consists of 16 field coils connected in series of which eight are open and eight are closed. The “open and closed” coils alternate. Thus the series connecting straps do not crisscross on every other coil to get alternating polarity.

2.0 MAINTENANCE

The alternator should be inspected and cleaned at intervals specified in the applicable Scheduled Maintenance Program. Operation and service, to which the generator is subjected, will determine the extent of maintenance required.

2.1 INSPECTION

2.1.1 CABLES AND TERMINAL BOARD

Ensure tightness of all mechanical and electrical connections. Cable connections to the terminal board and brush holders should be intact. Using dry cloths, wipe away any accumulation of dirt.

2.1.2 COLLECTOR RINGS, BRUSHES, AND BRUSH HOLDERS

The collector rings, Figs. 5 and 6, should be checked frequently while generator is in operation. Eliminate sparking conditions immediately. Normally, the negative ring will experience wear more rapidly than the positive ring. To minimize the unequal wear, reverse the ring polarity at six-month intervals.

The following conditions may result in sparking on collector rings:

1. Collector rings not running concentric with shaft.
2. Collector ring surface rough or pitted.
3. Brushes tight in brush holder.
4. Oil on surface of collector ring.
5. Vibration of brush holder studs.

If collector ring surfaces are oily, wipe off the surface of the rings and brushes with a clean, dry, bound edge cloth.

A rough or pitted collector ring surface is usually due to prolonged sparking. Usually this condition can be corrected by grinding.

On the AC generator/alternator installation, collector ring concentricity should be within 0.15 mm (.006”) total indicator reading (rings installed on generator), and lateral run-out within 0.8 mm (1/32”). If these tolerances are exceeded, the rings will have to be machined. The diameter of a new ring is 279.40 mm (11.000”), Fig. 7. The minimum acceptable diameter on the collector rings is 260.35 mm (10 – 1/4”). If rough rings cannot be cleaned up without going below the minimum diameter, they should be replaced.

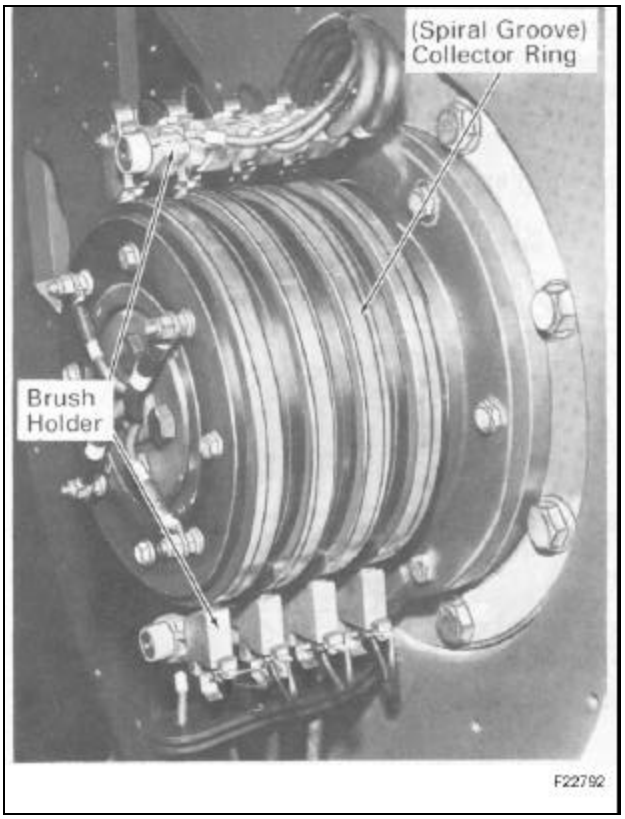

Fig. 5 – Typical AC Generator/CA Brush Holder and Collector Ring

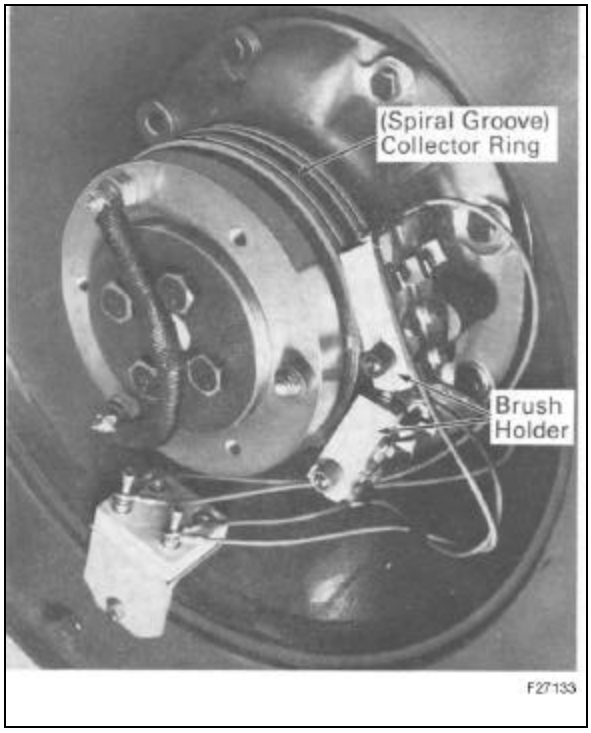

Fig. 6 – Typical DC Generator/CA Brush Holder and Collector Ring

WARNING!

Misapplication of generator and alternator collector ring leads can result in continuous excitation of the main generator from the alternator field leads. This condition could result in a serious accident when the diesel engine is running and placed on the line. If power contactors are picked up, the locomotive can inadvertently move when the isolation switch is placed in "run" position.

Qualified personnel should check continuity to ensure proper connection of collector ring terminals in the appropriate outboard and inboard collector rings. Two different cable sizes are used to connect the collector ring leads: Cable size 37/24 (smaller) and 125/24 (larger). Connect the smaller alternator cables to the outboard collector rings "1" and "2", and the larger generator cables to the inboard collector rings "3" and "4", Fig. 7.

To minimize the possibility of misapplied collector ring cables, alternator leads are marked "1" and "2" and generator leads "3" and "4". Collector rings are stamped correspondingly on the outboard faces adjacent to the insulation.

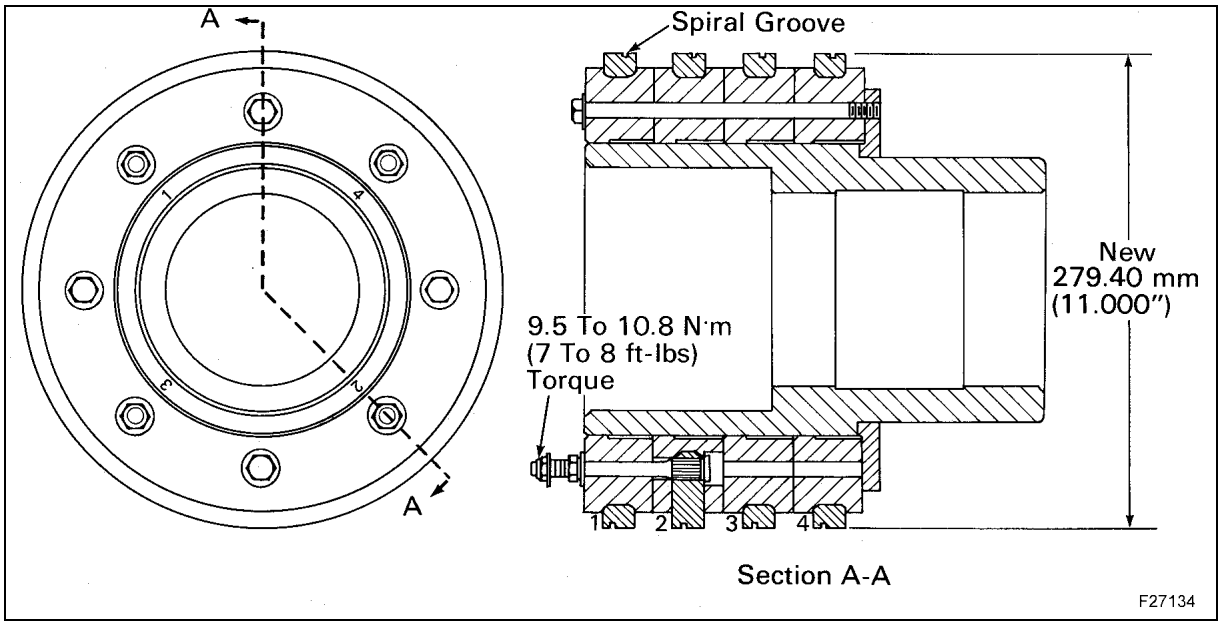

Fig. 7 – AC Generator Collector Ring Assembly, Cross-Section (AR11 Type Alternator Shown)

The DC generator/alternator installation collector rings are smaller, approximately 241 mm (9.5”). Collector ring concentricity should be within 0.15 mm (.006”) total indicator reading (rings installed on generator), and lateral run-out within 0.8 mm (1/32”). If these tolerances are exceeded, the rings will have to be machined or stoned. The diameter of a new ring is 236.52 mm (9.312”), Fig. 8. The minimum acceptable diameter on the collector rings is 225.42 mm (8.875”). If rough rings cannot be cleaned up without going below the minimum diameter, they should be replaced.

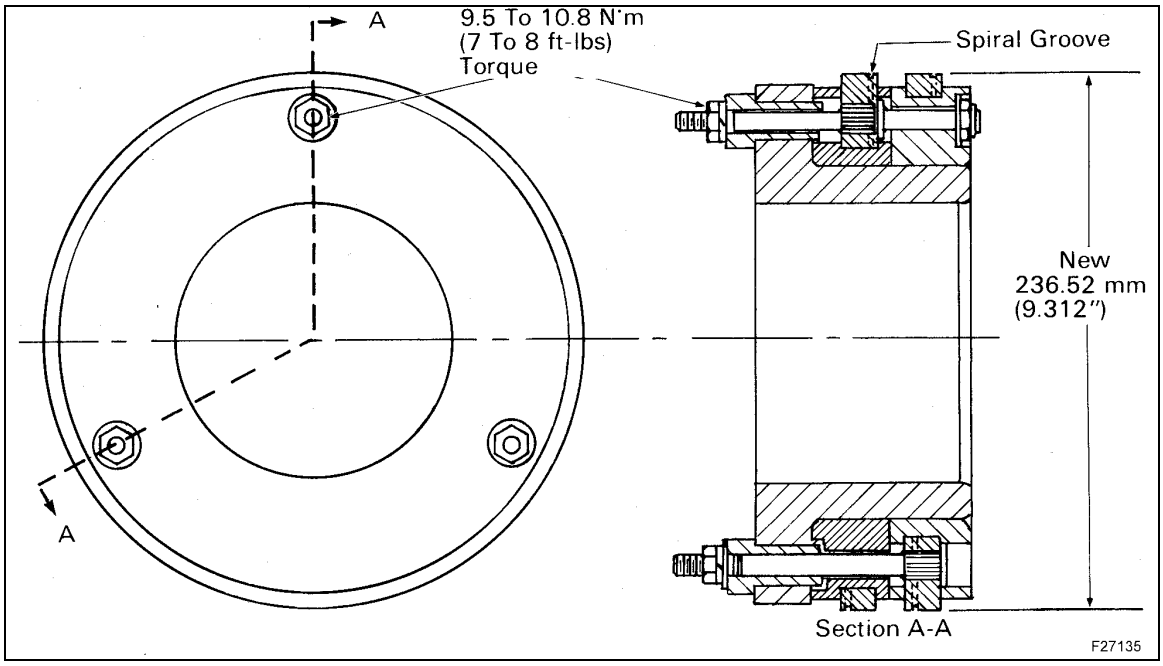

Fig. 8 – DC Generator Collector Ring Assembly, Cross-Section

Before grinding, remove brush holder assembly, and install the grinder and adapter to the applicable tapped holes or studs provided. Reference Service Data for grinding equipment.

Position the grinder so there will be 3-mm (1/8”) clearance between it and the rings to be ground. Install grinding stones in position on the grinder, making certain there will be enough travel to grind the rings. Figure 9 shows the grinding equipment in place.

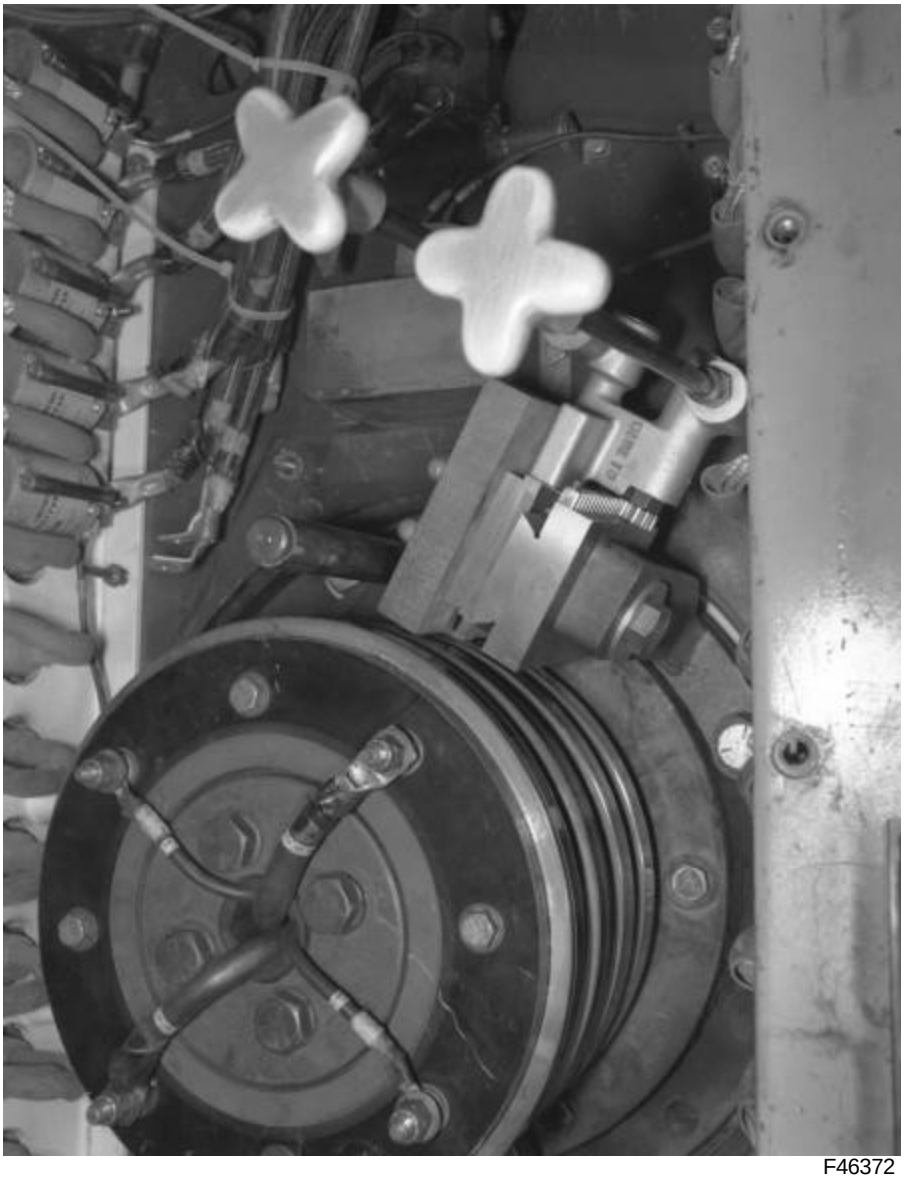

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Fig. 9 – Grinding Equipment Installation

Make the necessary preparation to start the engine, and run at approximately 600 RPM.

CAUTION!

Be sure the grinding stones do not contact the collector rings until the generator begins rotating. Then gradually bring the stones in contact with the rings.

When the stones are in contact with the rings, proceed to grind until the ring surface is smooth. After grinding, check the surface with a dial indicator. Concentricity should not exceed 0.15 mm (.006”) total indicator reading.

When the grind operation is complete, remove the grinding equipment. Blow out all grinding dust and reassemble the brush holder assembly in its proper position. Renew brushes if necessary, and follow instructions given under "Sanding-In" New Brushes.

CAUTION!

Because of the continued abrasive action, do not use emery cloth for polishing collector rings.

The spring pressure of the brush holders is preset and remains constant throughout the brush life regardless of wear.

Main generator brush spring pressure is 1.5 kg. (3.3 lbs.). CA brush spring pressure is 0.68 kg. (1.5 lbs.).

AC generators are equipped with eight constant pressure brush holders, Fig. 5, page 10, four mounted at the top of the collector ring assembly and four at the bottom. The brushes riding on the two inside collector rings are for the main generator and the two riding on the two outside collector rings are for the alternator.

NOTE

In certain applications there are 10 brushes, six for the main alternator and four for the CA5 alternator. The two extra holders are for the higher field current required in the main generator. These models include: AR17 (GP60), AR20 (SD70/75), TA17 (SD70MAC), TA20 (SD90MAC Phase II), TA22 (SD80/90MAC).

DC generators are equipped with four constant pressure brush holders, Fig. 6, page 10, two mounted at the top of the collector ring assembly and two at the bottom. The brushes riding on the collector rings are for the CA5 alternator. These alternator brushes are the same as those above having 0.68 kg. (1.5 lbs.) spring pressure. The main generator excitation is provided through the commutator and commutator brushes.

Ensure brush holder support bolts are tight to eliminate possible vibration.

2.2 CLEANING

2.2.1 GENERAL

If alternator is not disassembled, do not clean with a liquid cleaner. Dry compressed air at low pressure 207-345 kPa (30-50 psi) may be used to blow out dirt from the stator and rotor assembly.

CAUTION!
Do not use high air pressure since there is danger of loosening the insulation binding and blowing particles which may damage the insulation.

Where the use of low air pressure and dry cloths proves ineffective in removing imbedded deposits of dirt, a stiff brush, soft wood, or fiber scrapers may be used. In severe cases (to prevent surface creepage), dampen a cloth in solvent such as Stoddards Solvent to loosen and remove the dirt from rotating field terminals and connectors.

CAUTION!
Ensure there is adequate ventilation and safety precautions are observed when handling inflammable fluids such as Stoddards Solvent, which has a flash point of 46°C (115°F).

After cleaning, paint connectors and field coil connections with red air drying enamel. When enamel has dried, apply black air drying varnish. Refer to Service Data for red air drying enamel and black air drying varnish part number.

2.3 “SANDING-IN” NEW BRUSHES

When new brushes are installed, they should be “sanded-in” by placing a piece of No. 00 grade sandpaper under the brush with the sand side contacting the brush and moving the sandpaper in the direction of rotation, Fig. 10. Lift the brush when moving the paper back, and keep the paper close to the rings to avoid rounding the edges of the brush.

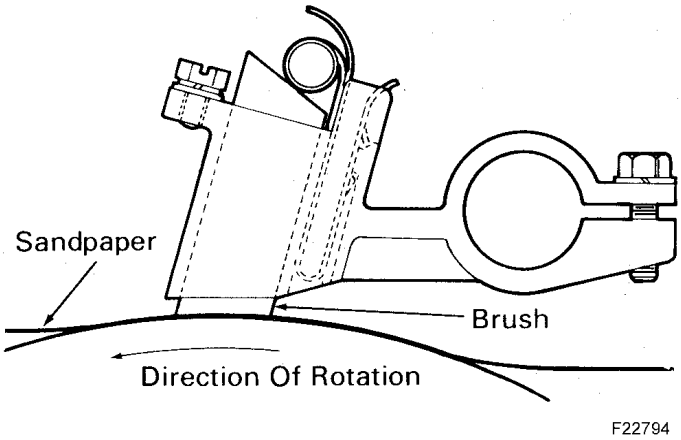

Fig. 10 – “Sanding-In” New Brushes

Seat one brush at a time; repeat the procedure for the remainder of the brushes.

CAUTION!
Do not use carborundum, emery cloth, or emery paper for “sanding-in” brushes.

NOTE
Brushes now on the market have a pre-sanded contour and do not require the “sanding-in” process. This process is only necessary for brushes that still have a flat, not the contoured, surface.

2.4 INSULATION RESISTANCE MEASUREMENTS

Using a megger, make an insulation resistance test on the rotor and stator. This should be done prior to making the high potential test. Readings of one megohm or better are satisfactory.

2.4.1 ROTOR

Field coil terminals and connectors should be thoroughly cleaned on both sides prior to making an insulation test. A low reading is likely to result if this is not done.

To test the rotor insulation, isolate the winding by lifting all the brushes off the collector rings. Connect the megohmmeter round lead to the generator rotor or engine flywheel rather than to the frame of the machine. The other lead is connected to the collector ring.

2.4.2 STATOR

Connecting the megger ground lead to the alternator frame and the other lead to the stator winding being tested checks the stator insulation. Be sure insulation resistance of the line cables to AC cabinet is not included.

3.0 DISASSEMBLY AND OVERHAUL

3.1 GENERAL INFORMATION

The alternator assembly should be removed from the generator and overhauled at intervals specified in the Scheduled Maintenance Program.

Overhaul consists of disassembly, major component inspection and cleaning, and replacement of worn or defective parts. Special processing to ensure adequate dielectric strength of components is ensured by the specified varnish treatment.

NOTE
Insulation naturally deteriorates from the adverse affects of age, dirt, heat, and moisture. Deterioration can be slowed by proper service and care.

Equipment tested and approved after overhaul should perform satisfactorily between scheduled overhaul periods.

CAUTION!
Ensure that different types of rotors and stators are not mixed in one machine.

3.2 IDENTIFICATION – D-14 Versus CA5 (D-18)

The CA5 and D14 stators are both "form" wound which makes them virtually identical in appearance. The D18 stator, however, is "random" wound which makes it more easily distinguished from either the D14 or the CA5 stators. Moreover, all three of these stators fit within the same dimension outer frame, which makes it especially important that the correct stator be matched to the correct rotor.

The proper stators and rotors can be identified in the following ways:

3.2.1 STATOR

1. The serial number and model (CA or D) are stamped on the nameplate applied to the outer frame. This number, however, can be misleading if a different stator was installed in the outer frame without changing the number stamped on it.

2. Verify the stator resistance values as per Table 1 in the Service Data Section of this M.I.

3. Phase lead markings as shown in Fig. 11, page 19.

NOTE
The CA5 has 14 phase leads compared to 12 on the D14. Phase leads 5 – 2 and 4 – 2 have two leads connected to one terminal as shown in the sketch of the CA5. Also, the CA5 phase leads are connected to the first and third row of terminals on the 12 point terminal boards, whereas, the D14 uses the first and second row of terminals.

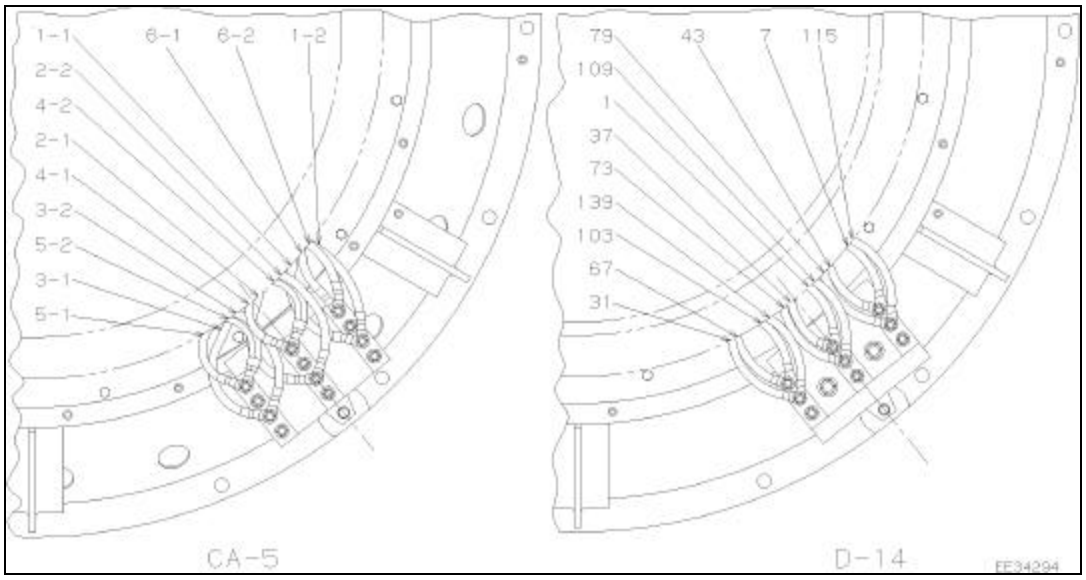

Fig. 11 – CA5 Alternator and D14 Alternator

3.2.2 ROTOR

The resistance values of a complete rotor assembly may be verified using Table 1 in the Service Data Section of this M.I.

The lamination stack length is as follows:

a. D14 – 5 in.
b. CA5 (D18) – 6 – 3/32 in.

The two rotor poles are shown below:

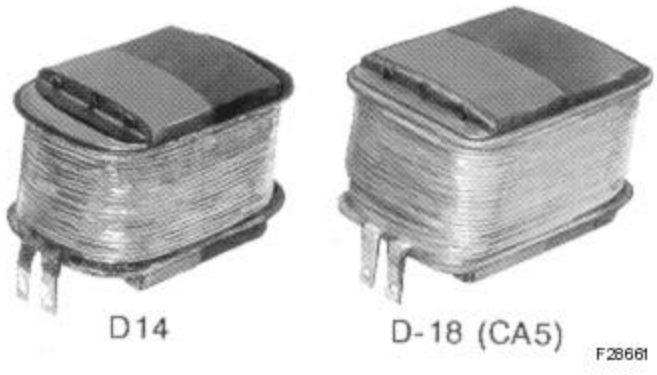

Fig. 12 – Rotor Pole Comparison

3.3 REMOVING ALTERNATOR STATOR

To remove the alternator stator from the generator frame, proceed as follows. Refer to Fig. 3 or 4 as applicable.

1. Remove generator coupling disc and alternator stator closure assembly.

2. Support alternator stator with a crane and a steel cable through a clevis pinned in the hole in the top center rib of the alternator stator frame.

3. Remove bolts holding alternator stator frame to generator (stator) frame.

4. Install three 1/2" – 13 jacking bolts in the tapped holes provided in the alternator stator frame. Rotate jacking bolts evenly, taking care to avoid binding.

5. Remove alternator stator over alternator rotor poles. Handle with care to prevent damage to laminations or windings.

3.4 REMOVING ALTERNATOR ROTOR

Perform the following procedure to remove the alternator rotor from main generator after the alternator stator has been removed. Refer to Figs. 3 or 4 as applicable.

1. Disconnect the leads at the collector ring terminal posts.

2. Remove the shaft flange and conduit busing at the collector ring end of the shaft.

3. Support the alternator rotor using an alternator rotor-lifting sling, as shown in Fig. 12, and a crane. Refer to Service Data for file Drawing number of sling.

4. Remove bolts connecting alternator rotor to the generator rotor.

5. Place jacking screws in the holes provided and remove alternator rotor.

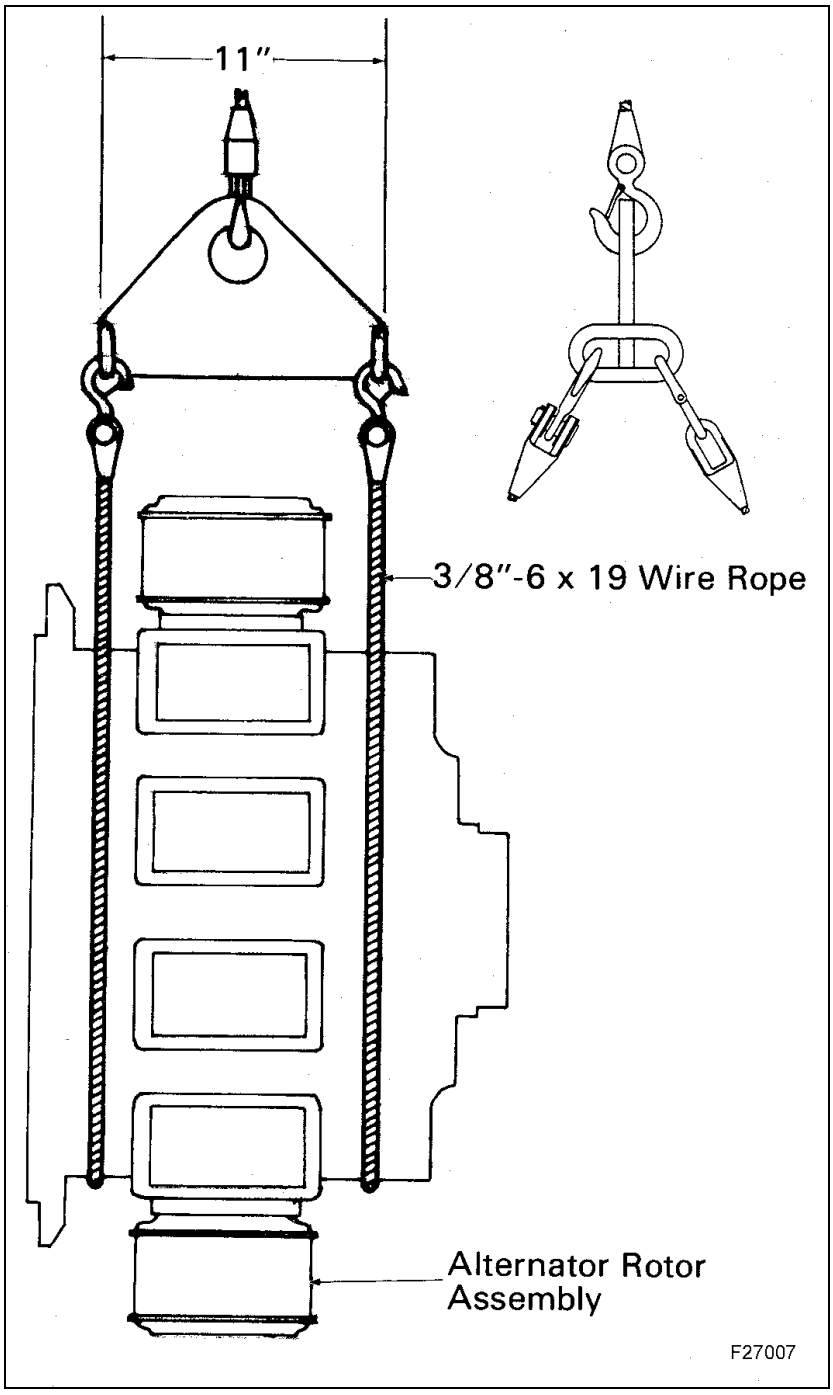

Fig. 13 – Alternator Rotor Support

3.5 ROTOR OVERHAUL

Perform the following procedures as applicable, to repair or overhaul the alternator rotor.

3.5.1 ROTOR CLEANING PRIOR TO VARNISH TREATMENT

After separating the alternator rotor from the generator rotor, perform either of the following cleaning procedures in preparation for varnish treatment. Position the rotor to allow access to all areas during the cleaning process.

3.5.1.1 WET METHOD

The rotor may be cleaned with a steam cleaner such as Dober Chemical Corporation Cleaner 6006 or Turco Chemical Company Steamfas.

Use an 85 g per 3.79 liter (3 oz./gal.) mixture of cleaner and water and maintain a tank temperature of approximately 60° C to 71° C (140°F to 160°F).

WARNING!
Protect skin and clothing while steam cleaning. Operator should wear rubber apron, boots, gloves, and a plastic face shield.

Steam clean the stator assembly as follows.

NOTE
The solution tank should be approximately 0.9 m x 1.2 m x 0.9 m (3’ x 4’ x 3’). Two steam guns are required such as Hurriclean Steam Guns, Model 551.

1. Regulate a No. 1 steam gun to obtain a good soapy solution.

2. Steam clean stator holding No. 1 steam gun nozzle at an angle to the stator about 100 mm to 150 mm (4” to 6”) away.

3. Rinse the stator thoroughly using a No. 2 steam gun with a combination of clean water and steam to remove all traces of cleaner.

4. Blow off stator using high volume, low pressure, clean, dry, compressed air.

5. Thoroughly dry rotor by placing in an oven at a regular temperature of 150° C (302°F) for 8 hours.

3.5.1.2 DRY METHOD

An alternate, satisfactory cleaning method employs the use of granulated corncob material applied with a controlled air blast. This method produces a clean, oil free surface ready for immediate varnish treatment.

When using this method, care should be exercised, as it is possible to remove varnish and cut into the layers of insulation by prolonged application of the blast material. Pressure used should be between 300 to 400 kPa (45 to 60 psi).

The corn cob material trapped in the pockets or crevices of the rotor should be removed by a straight air blast at reduced air pressure.

3.5.2 ROTOR POLE INSPECTION AND TEST

3.5.2.1 LOOSE POLE CHECK

1. Inspect pole connectors for fatigue cracks, faulty connections, or burned insulation. A broken coil-connecting strap will be evident by an open alternator field circuit and most likely indicates a loose pole.

2. Closely examine the area between pole piece and spider. A rust-like substance indicates a fretting condition.

3. Perform a pole tap test by tapping pole piece with a copper bar or lead mallet, while at the same time, holding a finger at the point between the pole and the spider. Movement indicates looseness at this point. Do not tap coil or insulation. Refer to Repair Recommendations section of this Maintenance Instruction if loose pole pieces are found.

3.5.2.2 ROTOR INSULATION RESISTANCE AND HIGH POTENTIAL TEST

Perform an insulation resistance test to field winding circuit with a megger. Megger indication of 15 megohms minimum is satisfactory for hi-pot test.

If megger indication is less than 15 megohms, bake the rotor in an oven at 130°C ± 10° (266°F ± 18°) to remove any moisture which may be causing low indication. Repeat megger test when the rotor is at room temperature. If megger indication is 15 megohms or better, proceed with hi-pot test. If indication is below 15 megohms, disconnect connector straps and use megger to locate defective coil(s). Replace any defective coil with a serviceable coil.

Perform hi-pot test to ground at 1700 volts for 10 seconds on new and 1000 volts for 10 seconds on used machines.

NOTE
The connector blocks have unusual insulation resistance characteristics; this must be considered when interpreting megger readings. If a megger indication is less than 15 megohms on a clean rotor, the coil terminal should be disconnected from the block and the individual coils meggered to ground. Individual coil readings should be 250 megohms or more. If so, reconnect the coil to the blocks, and perform the hi-pot test. Refer to Hi-Pot General Information prior to performing test.

3.5.3 ROTOR REPAIR RECOMMENDATIONS

1. If there are any broken rotor pole studs, or if the studs should break during the tightening process, renew all pole studs for that particular pole.

2. To tighten rotor pole assembly, torque each 5/8-18 pole stud/nut to a minimum of 237.27 – 264.38 N•m (175-195ft. – lbs.). Rap the pole piece head sharply with a lead or copper mallet, and again torque each pole stud/nut to 237.27 – 264.38 N•m (175-195 ft. – lbs.). Note: For CA8 rotor coil 7/8-14 bolts perform the same torque sequence, but torque to 684.69 – 711.80 N•m (505-525 ft lbs).

To replace a pole piece assembly, proceed as follows:

1. Remove the defective pole assembly.

2. Install proper new pole assembly with new studs. There are eight open and eight crossed alternator field coil assemblies, Fig. 14. These field coil assemblies should be installed so no two like assemblies are adjacent.

Apply thread lubricant, such as Texaco Threadtex No. 2303, to pole studs at time of installation. Refer to Service Data for thread lubricant part number.

3. Perform a polarity test of the rotor poles as follows:

    a. Apply 15 volts to rotor field coil circuit.

    b. Hold compass at center of a rotor coil. Compass should indicate a north or south pole indication. Move compass from pole to pole. Each coil should indicate a definite change in polarity. If compass does not indicate a polarity change, either two poles of the same polarity are positioned next to each other or there is a wrong connection at the connector blocks. Replace wrong coil with proper coil or repair defective connection.

NOTE

When installing a new pole assembly, it is advisable to match the weight of the pole being replaced as closely as possible to simplify balancing.

4. Check poles for spacing and parallelism. Measure the distance between poles, on the sides of the laminations, half way between the brass end pieces. A variation of 0.8 mm (1/32") between maximum and minimum readings is allowed on this dimension. Pole axis should be parallel with the main rotor axis within 0.8 mm (1/32") in the length of the laminations. Maintain a 1.6-mm (1/16") clearance between the coil surfaces of any two adjacent poles. Refer to Fig. 14.

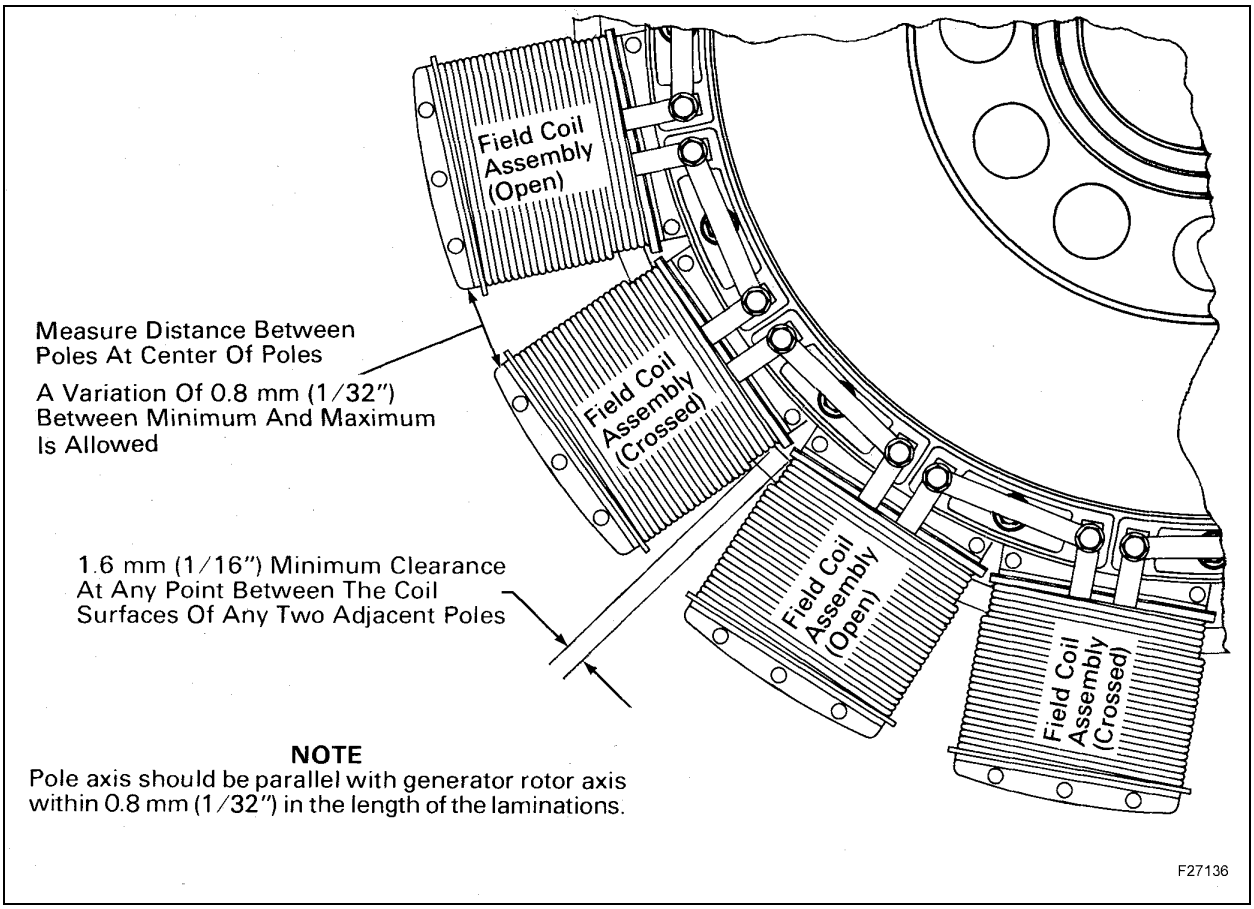

Fig. 14 – CA Type Alternator Rotor Pole Assembly

5. Torque each pole stud to 251 N•m ± 14 (185 ft. – lbs. ± 10).

6. It is recommended that the cables to field coils be replaced whenever the rotor is being overhauled.

7. Whenever a pole assembly has been removed, or one or more new poles have been replaced, the rotor assembly should be dynamically balanced within 0.056 N•m (8-in. oz.).

8. High potential test the entire field coil circuit to ground at 1700 VAC for 10 seconds on new and 1000 volts AC for 10 seconds on used machines.

WARNING!
Insulate the end of the two cables to prevent injury to personnel.

9. Resistance test entire field coil circuit using at least 8 amperes through the field coils. Compare resistance values with Table 1 in the Service Data Section.

10. Paint cable connections, bolts, and nuts, inside of spider, plate, and conduit with red air drying enamel. Take care to keep enamel off all finished surfaces.

3.6 STATOR OVERHAUL

The alternator stator is connected to the terminal bus bars as shown in Figures 15a through 15e.

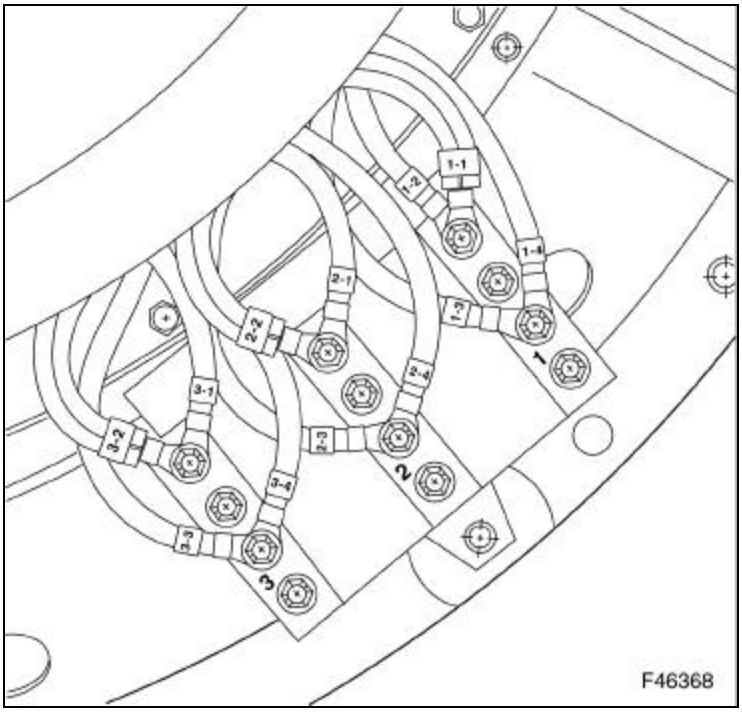

Fig. 15a – CA5 Alternator Stator Connection Diagram

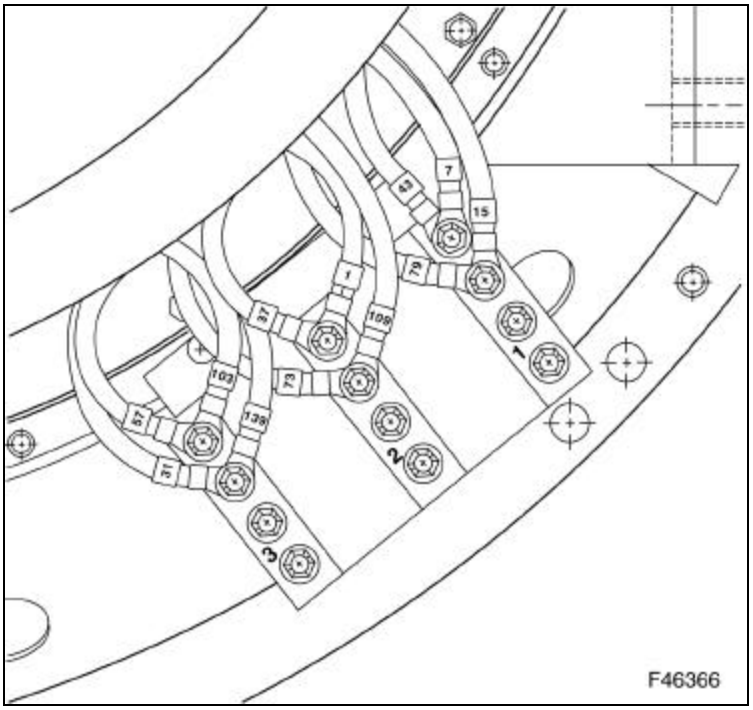

Fig. 15b – CA6 Alternator Stator Connection Diagram

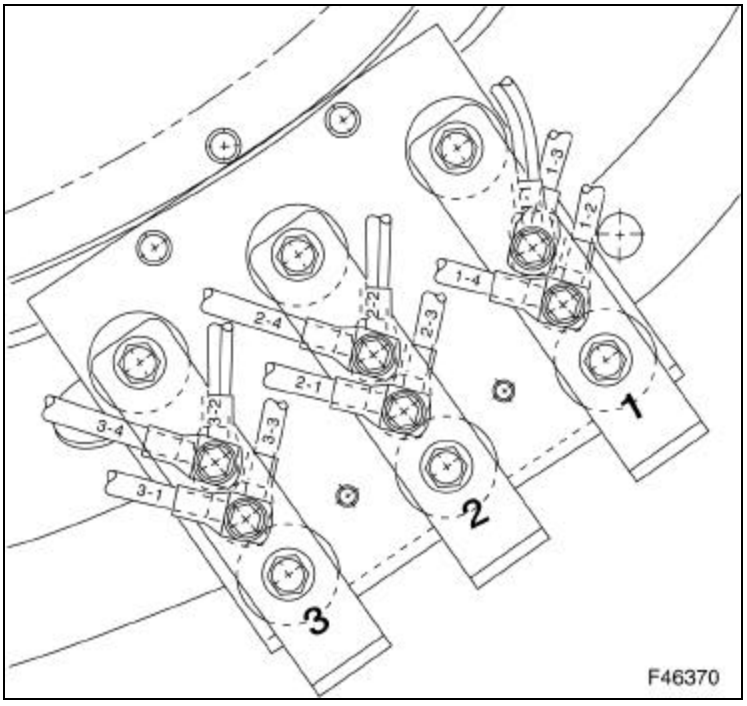

Fig. 15c – CA7 Alternator Stator Connection Diagram

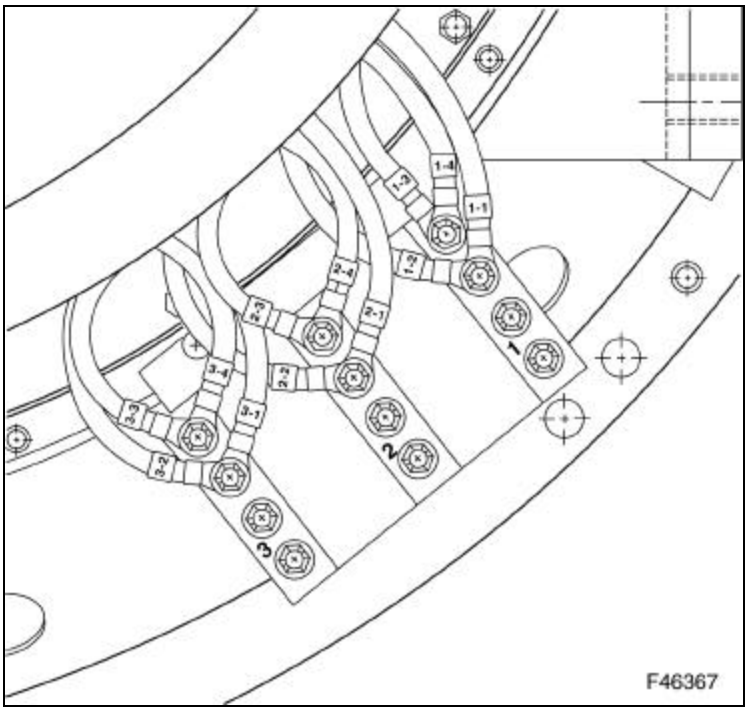

Fig. 15d – HE7 Alternator Stator Connection Diagram

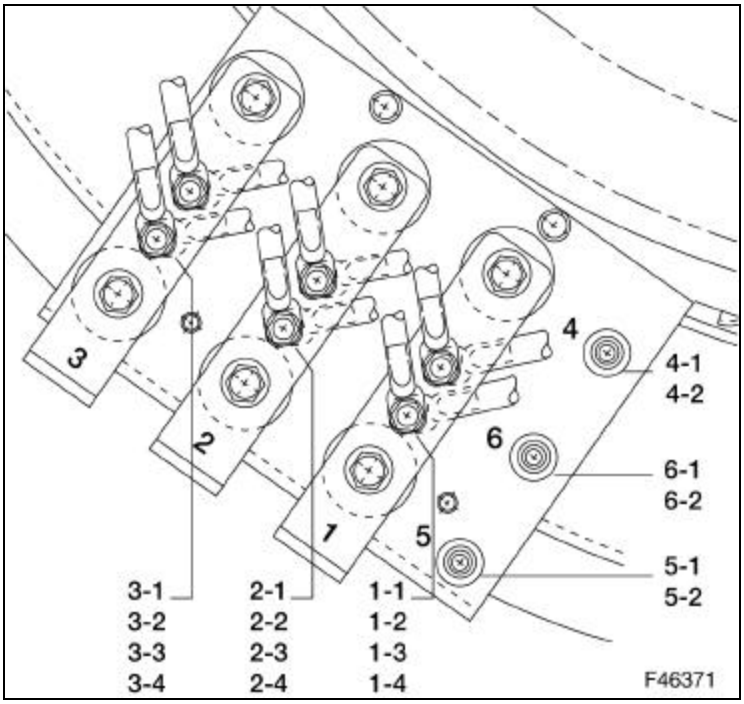

Fig. 15e –CA8 Alternator Stator Connection Diagram

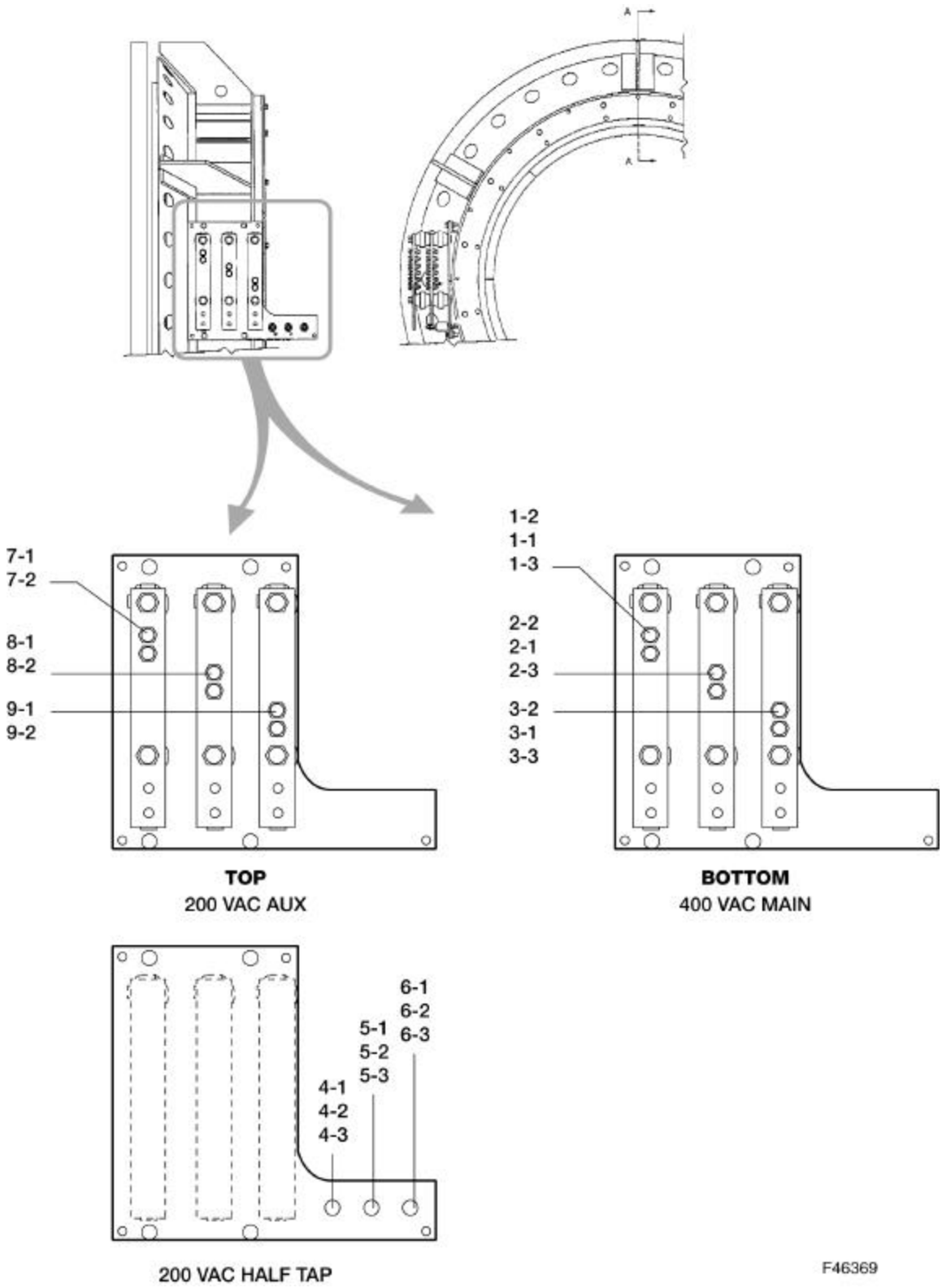

Fig. 15e –CA9 Alternator Stator Connection Diagram

3.6.1 REWIRED STATOR ELECTRICAL WINDING CONNECTION CHECK

If stator has been rewired, test the stator windings for proper connection with a suitable surge comparison tester. For this test connect all phase 1 terminal lugs together, connect all phase 2 terminal lugs together, and connect all phase 3 terminal lugs together. Testing voltage should be 1700 volts. Compare phase 1 to phase 2, phase 1 to phase 3, and compare phase 2 to phase 3. This testing is performed by comparing all the coils of one phase against all the coils of another phase. A proper connection will be exhibited similar to Figure 16 and a bad connection will be exhibited similar to Figure 17.

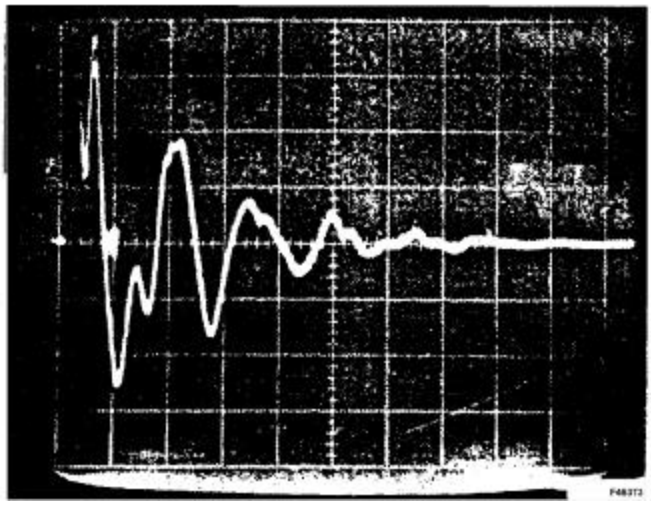

Fig. 16 – Three Parallel Coil Groups (Proper Traces)

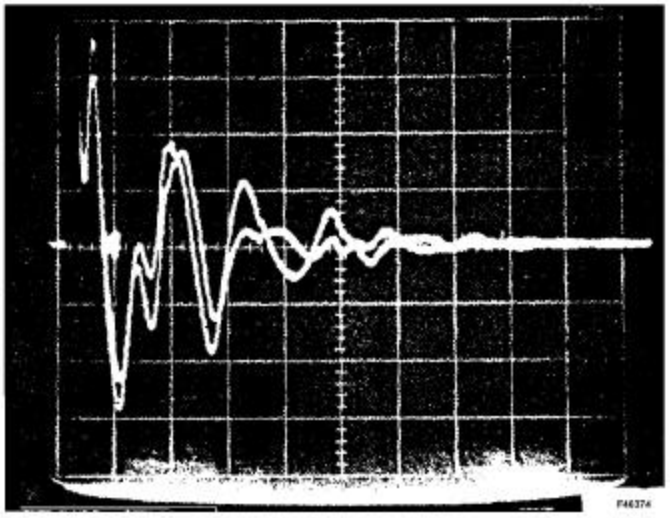

Fig. 17 - Three Parallel Coil Groups (Improper Traces – Incorrect winding)

3.6.2 STATOR INSULATION RESISTANCE AND HIGH POTENTIAL TEST

Perform an insulation and resistance test to the stator windings using a megger. If megger indicates less than 2 megohms, bake stator in an oven at 125°C (257°F) for 4 hours, to remove any moisture. If minimum of 2 megohms is obtained, proceed with high potential test.

Perform high potential test to ground at 1500 volts for 10 seconds on new and 1000 volts for 10 seconds on used machines.

3.6.3 PHASE-TO-PHASE RESISTANCE TEST

Perform a phase-to-phase resistance test between the stator terminals. Ensure the readings taken are compared with the appropriate model listed in Table 1 of the Service Data Section.

On CA5, 6, and 7 machines, measure the resistance between terminals 1 and 2, terminals 2 and 3, and terminals 1 and 3.

For CA8 machines, measure the resistance between terminals 1 and 2, terminals 2 and 3, terminals 1 and 3, terminals 4 and 5, terminals 5 and 6, and terminals 4 and 6.

For CA9 machines, measure the resistance between terminals 1 and 2, terminals 2 and 3, terminals 1 and 3, terminals 4 and 5, terminals 5 and 6, terminals 4 and 6, terminals 7 and 8, terminals 8 and 9, and terminals 7 and 9.

3.6.4 STATOR CLEANING PRIOR TO VARNISH TREATMENT

Clean stator with granulated corn cob material applied with a controlled air blast. This method produces a clean, oil free surface ready for immediate varnish treatment.

Care should be exercised, as it is possible to remove varnish and cut into layers of insulation material.

Pressure used should be between 300 to 400 kPa (45 to 60 psi).

The corn cob material trapped in the pockets or crevices of the stator should be removed by a straight air blast at reduced air pressure.

Cover terminal lugs with friction tape to prevent varnish from getting on terminal lugs.

3.7 ROTOR AND STATOR ASSEMBLY VARNISH TREATMENT

Rotor and stator assemblies which pass the inspection and electrical test after all repairs have been complete, should be given a varnish treatment as follows.

Varnish should be thinned to maintain Ford Cup No. 4 orifice viscosity at 250 – 325 seconds at 21.1°C (70°F) and a minimum specific gravity of 0.900.

3.7.1 ROTOR ASSEMBLY

1. Heat rotor in a convection oven to 130°C ± 10° (266°F ± 18°) for a minimum of 2 hours.

2. Remove rotor from oven and megger test immediately. If megger indication is less than 2 megohms, refer to Rotor Repair section which follows. If megger indication is 2 megohms or more, continue with procedure. Do not allow rotor to cool below 100°C (212°F) prior to dip operation.

3. Dip rotor in varnish tank and allow it to soak for 5 minutes.

4. Remove rotor from varnish tank and allow it to drain for 5 minutes.

5. Clean varnish from mounting surfaces using a cloth saturated with solvent.

6. Bake rotor for 5 hours in an oven set not to exceed 160°C (320°F).

7. When rotor has been allowed to cool to room temperature, check with megger. Rotor must measure a minimum of 15 megohms.

3.7.2 ROTOR REPAIR PROCEDURE

1. If rotor does not meet electrical minimum requirement, disconnect coil leads and check with a megger to determine defective coil(s). Individual coil resistance to ground should be 250 megohm minimum.

2. If old coils are used as replacement coils, varnish treatment will have to be repeated even if varnish treatment had been previously completed. When new coils are used, varnish treatment will not have to be repeated.

3.7.3 STATOR ASSEMBLY

1. Heat stator in a convection oven to 130°C ± 10° (266°F ± 18°) for a minimum of 2 hours.

2. Remove stator from oven and immerse in varnish tank for 10 minutes. Do not allow stator to cool below 100°C (212°F) prior to dip operation.

3. Remove stator from varnish tank and allow it to drain for 10 minutes.

4. Heat stator for 2 hours at 160°C (320°F) maximum oven temperature.

5. While stator is 100° to 120°C (212° to 248°F), dip stator in varnish tank for 2 minutes.

6. Remove stator from varnish tank and allow it to drain for 5 minutes.

7. Heat stator for 3 hours at 160°C (320°F) maximum oven temperature.

8. While stator is 100° to 120°C (212° to 248°F), dip stator in varnish for 2 minutes.

9. Remove stator from varnish tank and allow it to drain for 5 minutes.

10. Heat stator for 5 hours at 160°C (320°F) maximum oven temperature.

11. Clean varnish from all machined surfaces, tapped holes, and mounting pads immediately after oven-bake while stator remains hot and varnish is soft.

4.0 HI-POT GENERAL INFORMATION

It is extremely important that the high potential test equipment be reliable to ensure adequate testing without unnecessarily overstressing the insulation.

In regard to the features that should be incorporated in the tester, the following points are pertinent: wave forms, surges, and voltage regulation.

4.1 WAVE FORM

Voltages specified in high potential testing are, unless otherwise specified, root-mean-square (RMS) voltages. The wave form should have a limit of 5% third harmonic. This limitation fixes the peak voltage for any RS voltage.

Waveform may be influenced by the capacity of the testing apparatus used relative to the size of the piece of equipment being tested. A serious peak on the voltage wave may result if the test box being used is too small for the piece of equipment tested. Also, it is possible that the leakage and charging current may be sufficient to trip the relay when testing a piece of equipment with a test box which is too small.

4.2 SURGES

Harmful surges may occur if special attention is not paid to the method of changing voltages on the primary when testing.

4.3 REGULATION

Specifications for regulation of high potential equipment state that the secondary voltage drop should not exceed 20% under actual test conditions.

4.4 SAFETY PRECAUTIONS

WARNING!
ELECTRICAL RATINGS of the test equipment are values that should be considered EXTREMELY DANGEROUS to personnel.

The following safety considerations should be carefully observed when performing hi-pot tests:

1. Except for the person performing the hi-pot test, all personnel should maintain a safe distance from equipment being tested before applying voltage.

2. Do not make or break the high voltage circuit with the electrodes. Dangerous over-voltage surges may result.

5.0 ALTERNATOR TO GENERATOR ASSEMBLY

5.1 ALTERNATOR ROTOR TO GENERATOR ROTOR

Bolt the alternator rotor to the generator rotor using the 7/8" – 9 bolts removed during disassembly. Ensure the alternator rotor leads are threaded through the generator rotor shaft. Torque the bolts to 813.49 N•m (600 ft.-lbs.).

5.2 ALTERNATOR STATOR TO GENERATOR STATOR

Bolt the alternator stator to the generator stator using the 3/4" – 10 bolts removed during disassembly. Ensure correct holes in the alternator stator ring line up with mating holes in the generator stator frame. The centerline of the 3/8" – 16 NC tapped hole, which is centered in a 76 mm (3") counterbore in the outer flange of the alternator stator, must line up with the centerline of the terminal board on the generator frame, Fig. 18, page 36. Torque bolts to 271 N•m (200 ft.-lbs.).

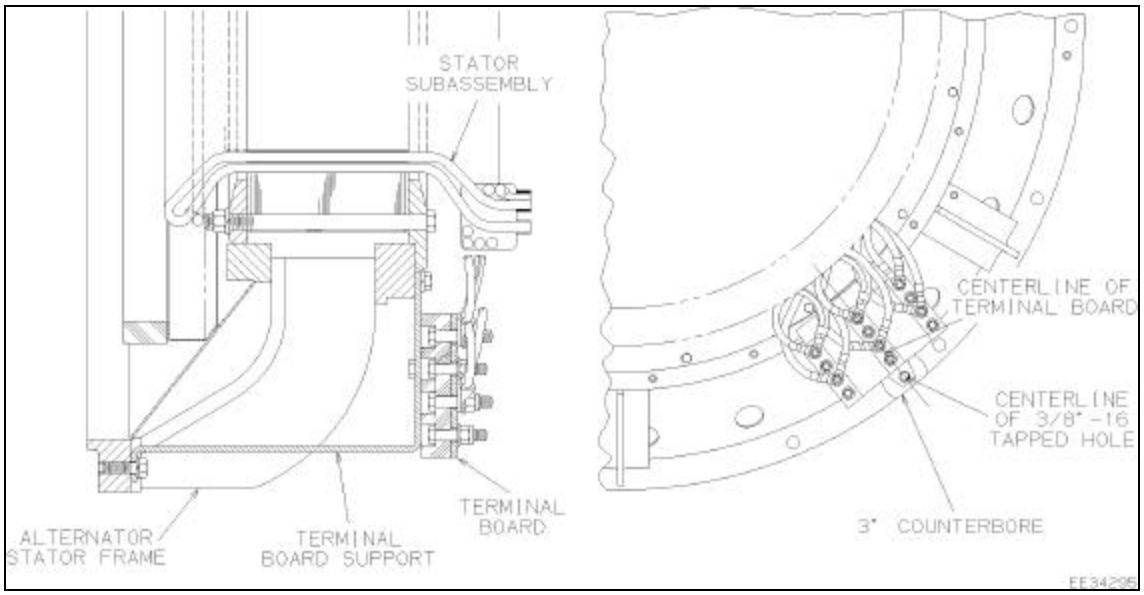

Fig. 18 – Typical Alternator Stator to Generator Stator Alignment

6.0 SERVICE DATA

6.1 SPECIFICATIONS

6.1.1 Brushes (Alternator Only)

Spring pressure, non-adjustable type..……...0.68 kg. ± 0.068 kg. (1.5 lbs. ± .15 lbs.)
Number of brushes ……....4
Number of brush holders ……..4
Size of brush …….. ……...9.53 mm x 19.05 mm x 55.56 mm (3/8" x 3/4" x 2 – 3/16")
Brush wear limit……...……...19 mm (3/4") on long side

6.1.2 Output Ratings

MODEL	OUTPUT	CIRCUIT	FIELD AMP.	RPM	NOM.	MAX.	MIN.
CA5	Main	-	60	900	227.5V	231V	224V
	Main	-	60	950	239.5V	244V	235V
CA6	Main	-	60	900	230V	237V	223V
	Main	-	60	950	243V	250V	236V
CA7	Main	-	60	900	235V	240V	230V
	Main	-	60	950	243V	253V	243V
CA8	Main	1-2-3	75	900	445V	460V	430V
	Main	1-2-3	75	1000	494V	510V	478V
	Main	1-2-3	75	1100	544V	562V	526V
	Secondary	4-5-6	75	900	225.5V	230V	215V
	Secondary	4-5-6	75	1000	247V	255V	239V
	Secondary	4-5-6	75	1100	272V	281V	263V
CA9	Main	1-2-3	20	900	262V	267V	257V
	Main	1-2-3	40	900	417V	425V	409V
	Main	1-2-3	60	900	478V	488V	468V
	Main	1-2-3	69	900	494V	504V	484V
	Secondary	4-5-6	69	900	248V	255V	241V
	Auxiliary	7-8-9	69	900	248V	255V	241V

Table 1 - Output Ratings

6.1.3 Resistance at 75°C (167°F)

Use the following formula to convert resistance measured at any temperature to resistance at 75°C (167°F):

$$\text{Resistance at } 75°C = \frac{\text{measured resistance} \times 309.5}{234.5 + \text{temperature of item being tested in °C}}$$

Model	Test	Nominal	Maximum	Minimum
CA5	Rotor (slip ring to slip ring)	1.51	1.54	1.48
	Stator (phase to phase)	.00355	.00370	.00340
	Maximum Variation Between 2 phases		.00004	
CA6	Rotor (slip ring to slip ring)	1.51	1.54	1.48
	Stator (phase to phase)	.00425	.00435	.00415
	Maximum Variation Between 2 phases		.00004	
CA7	Rotor (slip ring to slip ring)	1.405	1.440	1.370
	Stator (phase to phase)	.002285	.00233	.00224
	Maximum Variation Between 2 phases		.00003	
CA8	Rotor (slip ring to slip ring)	1.16	1.19	1.13
	Stator 1-2-3 (phase to phase)	.00570	.00600	.00540
	Stator 4-5-6 (phase to phase)	.00430	.00460	.00400
	Maximum Variation Between 2 phases		.00030	
CA9	Rotor (slip ring to slip ring)	1.57	1.180	1.134
	Stator 1-2-3 (phase to phase)	.00933	.00952	.00914
	Stator 4-5-6 (phase to phase)	.00517	.00527	.00507
	Stator 7-8-9 (phase to phase)	.00758	.00781	.00735
	Maximum Variation Between 2 phases		.00010	

Table 2 – Alternator Resistance Values

6.1.3 Air Gap (nominal)……..130”

6.1.4 Weights (Approx.)

CA5/6
Rotor…… 659 kg. (1450 lbs.)
Stator……468 kg. (1050 lbs.)

CA7/9
Rotor ……953 kg. (2100 lbs)
Stator ……601 kg. (1325 lbs)

CA8
Rotor ……..1188 kg. (2620 lbs)
Stator ……762 kg. (1680 lbs)

6.2 MATERIAL

Enamel, Red Air Drying
Approx. 1 liter (1 qt.)……..……..... 8061130
Approx. 19 liters (5 gal.)…….……... 8084876

Varnish, Black Air Drying
Approx. 4 liters (1 gal.)…….…… 8122347
Approx. 208 liters (55 gal.)……... 8116521

Thread Lubricant, Texaco Threadtex No. 2303 Approx. 19 liters (5 gal.)..
……...…….. 8307731

*Varnish, Electrical Insulating, Modified Polyester Approx. 208 liters (55 gal.)…
…….…….. 8489774

NOTE
Varnish mixture to have viscosity at 250 – 325 seconds using Ford Cup No. 4 at 21.1°C (70°F).

Thinner Solvents for Above Varnish
*Chevron No. 1300
*Thompson-Hayward Chemical Co. No. 2026
**Xylol Thinner

NOTE
Butyl acetate or butyl cellosolve is used with the following two thinner solvents because the varnish sets up in the tank when mineral spirits thinner are used alone.

Alternate Thinner…….9083470
*Mineral Spirits (Rule 66 Type Thinner) 80%
*Butyl Acetate, Technical Grade 20%

Alternate Thinner…….9544540
*Mineral Spirits (Rule 66 Type Thinner) 70%
*Butyl Cellosolve 30%

6.3 TOOLS

Megger, Insulation Resistance Test Set……..……..8174880
Leads, 3.7 m (12 ft.)……. ……8174878
Carrying Case…….……...8174879

Collector Ring Grinder Assembly……..…… 8219264
Adapter-Supports Collector Ring Grinder (small 8” bearing).……...… 9506268
Adapter-Supports Collector Ring Grinder (Large 10” bearing)……..…… 9506268
Grinding Stone, Coarse…….…...8260375
Grinding Stone, Medium……. 8496921
Grinding Stone, Finish.……8204167
Alternator Rotor Support (lifting tool)…….……†File No. 924
Brush Tension Testing (0 – 15 pound range)…….……..8415805

*To be used where compliance with pollution control regulations is required.
**Xylol may be used as a substitute thinner, however, Xylol DOES NOT comply with pollution control regulations.

†File Number represents facility drawings that are available (at no charge) from EMD Service Department. These drawings include construction details of tooling that can be manufactured.

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