

SERVICE DEPARTMENT



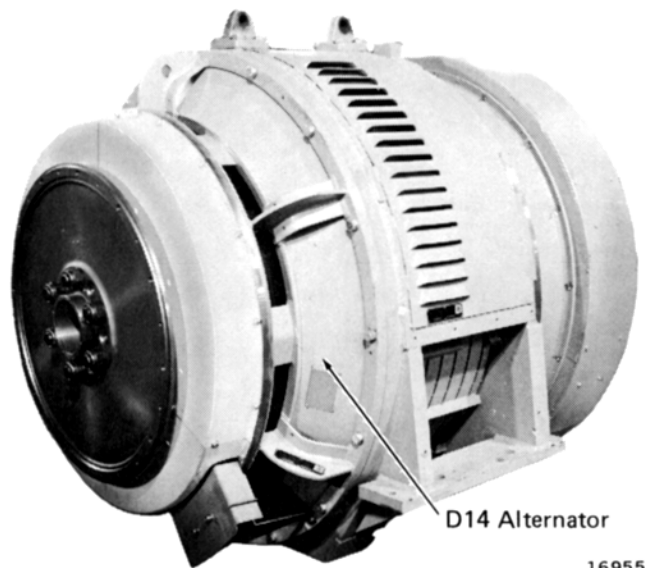
Electro-Motive Division
Of General Motors
La Grange, Illinois 60525

Maintenance Instruction

D14 ALTERNATOR

DESCRIPTION

The D14 alternator is a variable frequency, variable voltage, 3-phase, wye (Y) connected, 16 pole machine having a rotating field and stationary armature. As shown in Fig. 1, the D14 alternator is an integral part of the main generator. It has a rating of 100 KVA at 0.8 power factor.



D14 Alternator

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Fig. 1 - D14 Alternator

NOTE: For the purposes of this instruction, "alternator" will denote reference to the D14, while "AC or DC generator" will represent the applicable AR or D-type main generators, respectively.

The alternator is used to efficiently drive auxiliaries as the engine cooling fans and inertial filter blower motor, and also to provide current for excitation of the main generator. When driven by the engine at 900 RPM, the D14 alternator produces approximately 215 volts at 120 Hz.

*Information contained herein is applicable to equipment being produced as of the date of publication. Please retain your previous editions for use with earlier equipment.

The most apparent differences in the application of the D14 alternator to an AC or DC generator are in the collector ring assemblies. Collector ring size and number differ, Fig. 2 and 3.

A total of four 279.4 mm (11") collector rings sharing a common assembly are used on the AC generator application, Fig. 2. Main generator excitation is accomplished through the two inboard rings, and alternator excitation through the two outboard rings.

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.

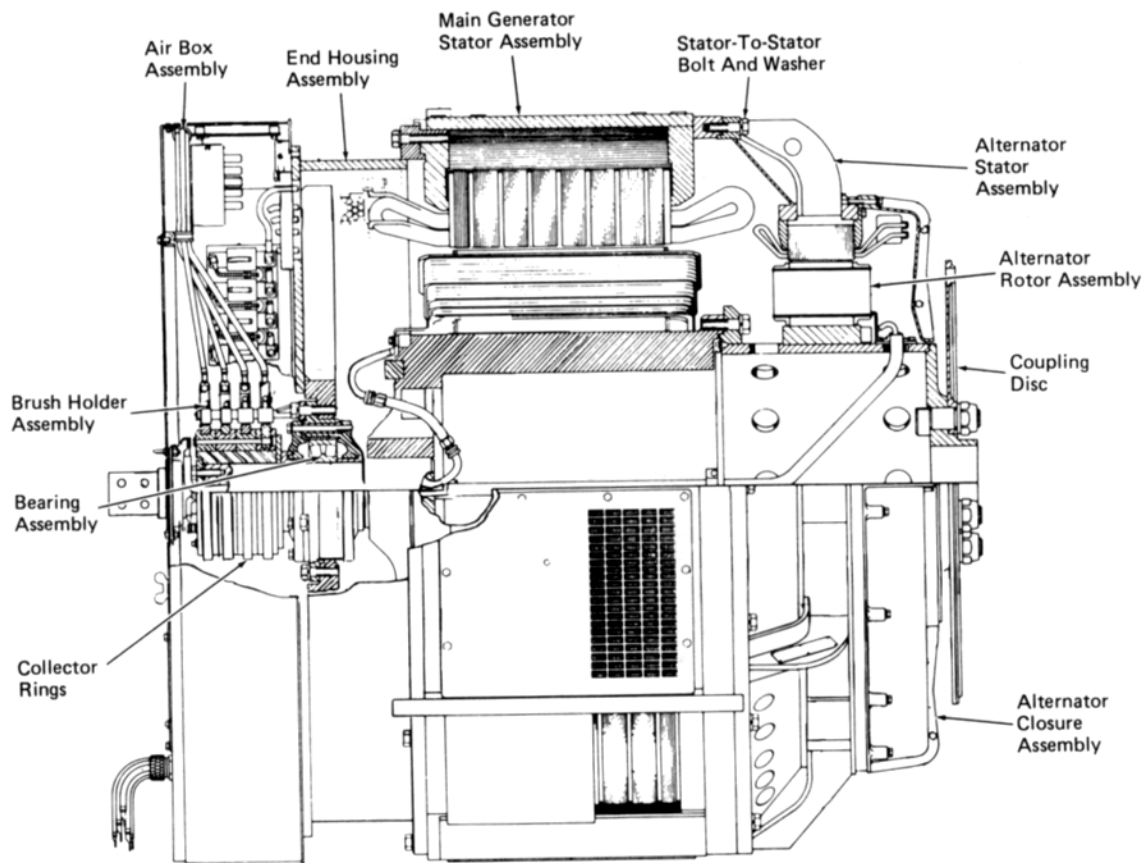
OPERATION

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.

The separately excited field consists of 16 main pole coils. The coils are connected in two series groups of 8 coils each, with the coils connected alternately inner and outer on adjacent poles. This is possible because the coils are wound alternately crossed and open, permitting opposite polarity at adjacent poles. The two series groups of 8 coils each are connected in parallel.

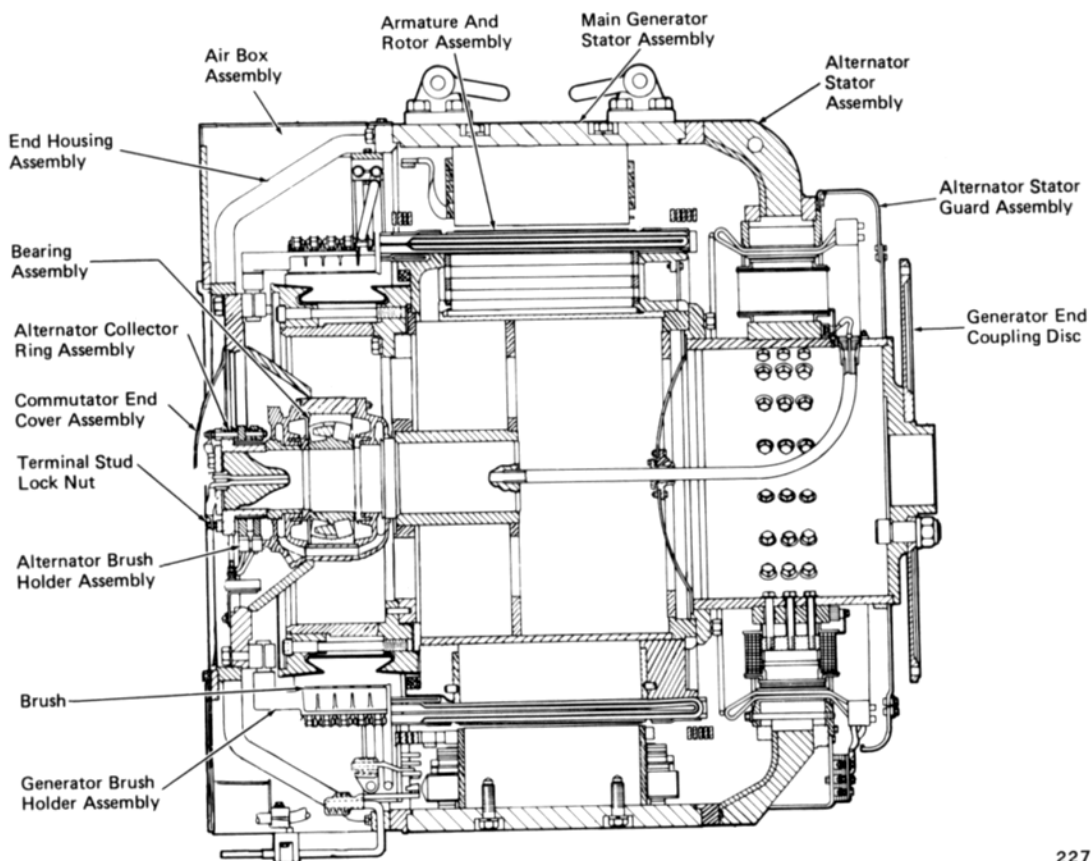
MAINTENANCE

The alternator should be inspected and cleaned at intervals specified in the applicable Scheduled Maintenance Program. The extent of maintenance required is determined by the operation and service to which the generator is subjected.



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Fig. 2 - Cutaway - Typical AC Machine



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Fig. 3 - Cutaway - Typical DC Machine

INSPECTION

CABLES AND TERMINAL BOARDS

Ensure tightness of all mechanical and electrical connections. Cable connections to the terminal board, Fig. 4, and brush holders, Fig. 5, should be intact. Using dry cloths, wipe away any accumulation of dirt.



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Fig. 4 - External Cable Connection

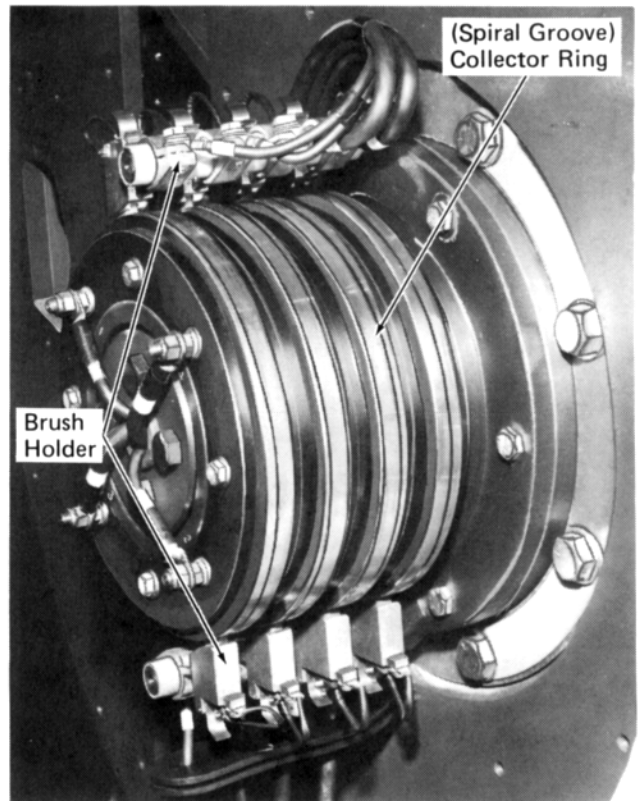
COLLECTOR RINGS, BRUSHES, AND BRUSH HOLDERS

The collector rings, Fig. 5 (a&b), 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:

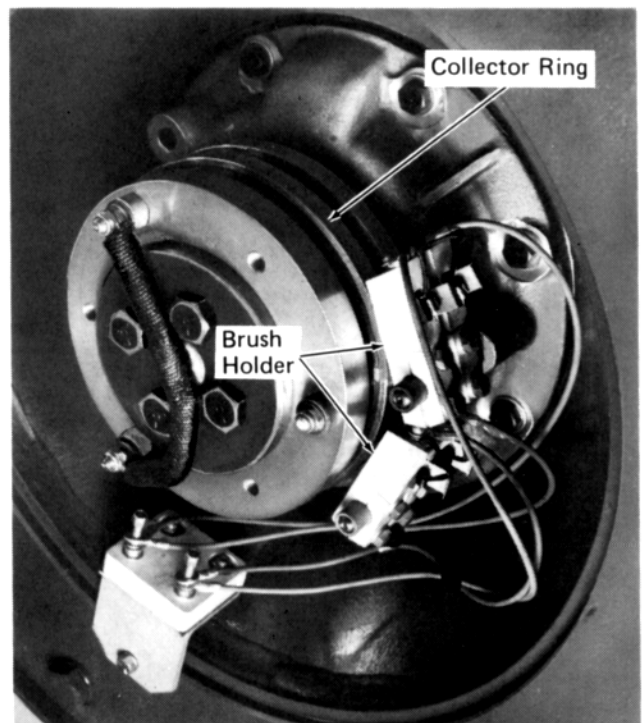
1. Collector rings not running concentric with shaft.
2. Collector ring surface rough or pitted.
3. Brushes tight in brush holder.
4. Oil on surface of collector ring.
5. Vibration of brush holder studs.

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



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Fig. 5a - Typical AR-Type/D14 Brush Holder And Collector Ring Cable Connection Application



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Fig. 5b - D32/D14 Brush Holder And Collector Ring Cable Connection Application

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

On the AC generator installation, collector ring concentricity should be within 0.15 mm (.006") total indicator reading (rings installed on generator), and lateral runout within 0.8 mm (.03" [1/32"]). If these tolerances are exceeded, the rings will have to be machined. 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.

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 to 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. 6.

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.

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 runout within 0.8 mm (.03" [1/32"]). If these tolerances are exceeded, the rings will have to be machined or stoned. 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.

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

Position the grinder so there will be 3.18 mm (.125" [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.

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.

AC machines are equipped with eight constant pressure brush holders, Fig. 5a, 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, whereas the brushes on the two outside collector rings are for the D14 alternator. The spring pressures exerted on the brush wafers are 1.5 kg (3.3 lbs), and 0.68 kg (1.5 lbs), respectively. These preset pressures will remain constant throughout the brush life regardless of brush wear.

The brush holder arrangement differs on a DC machine from that of the AC in that the alternator brush holder assembly is separately located from the main generator commutator brushes. There are four constant pressure brush holders, two mounted at the top of the collector ring assembly and two at the bottom. The alternator brushes are the same as those above having 0.68 kg (1.5 lbs) spring pressure.

To eliminate possible vibration, ensure tightness of brush holder support bolt.

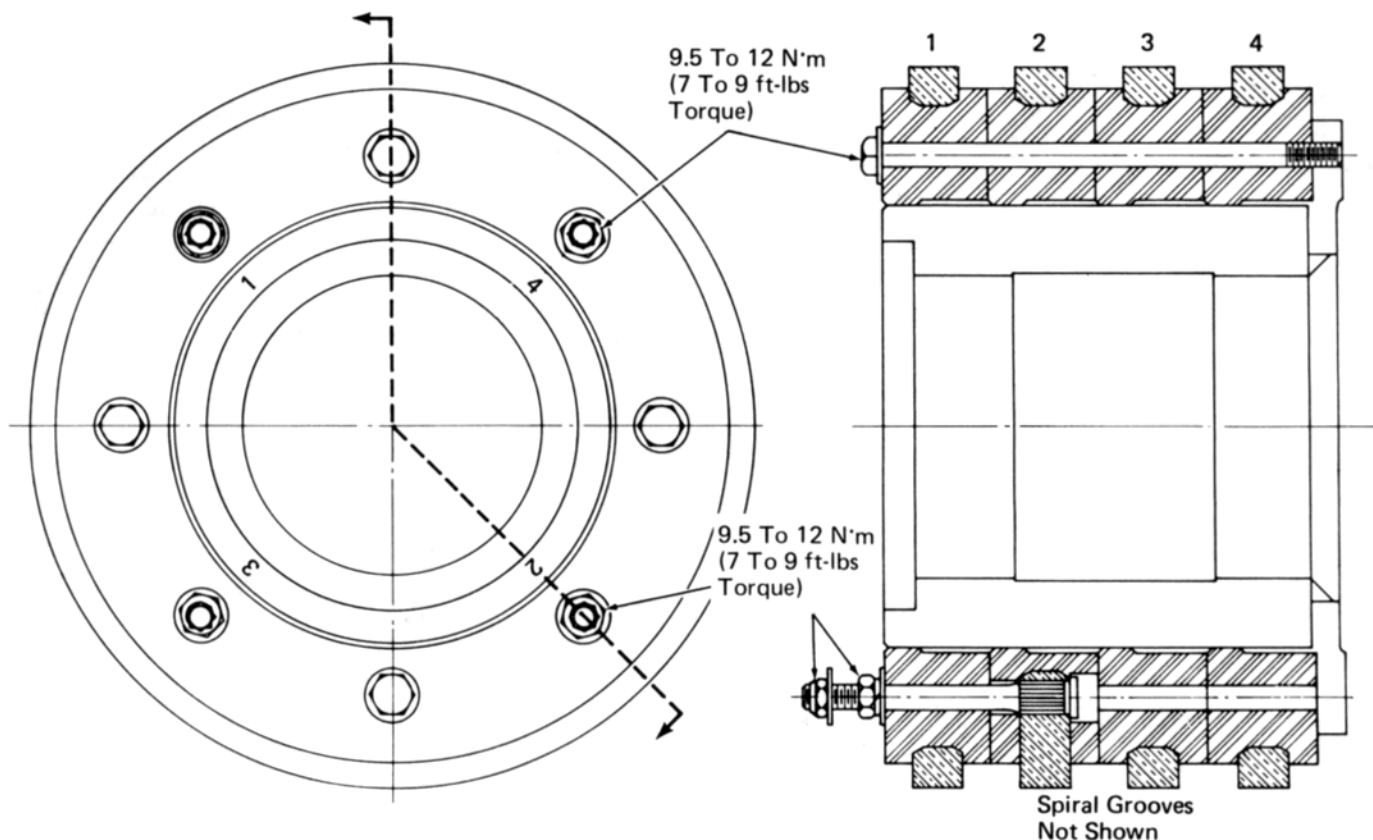


Fig. 6 - AR-Type (AC Machine) Collector Ring Assembly

CLEANING

GENERAL

Electrical equipment should not be sprayed or cleaned with a liquid of any kind. Attempting to clean the coils and windings with a liquid cleaner will destroy the protective coating, causing it to peel or crack.

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 ONLY** (to prevent surface creepage), dampen a cloth in alcohol or equivalent solvent, to remove the dirt from rotating field terminals and connectors.

After cleaning, paint connectors and field coil connections with red air drying insulating varnish. When this is dry, apply black air drying varnish. See Service Data.

"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. 7. Lift the brush when moving the paper back, and keep the paper close to the rings to avoid rounding the edges of the brush.

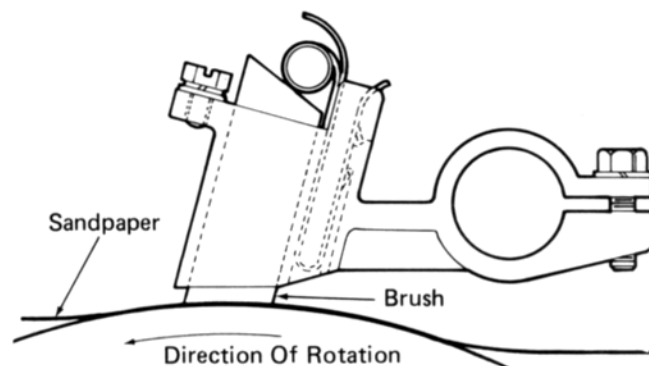


Fig. 7 - "Sanding-In" New Brushes

CAUTION: Do not use carborundum, emery cloth, or emery paper for "sanding-in" brushes.

INSULATION RESISTANCE MEASUREMENTS

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

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 ground 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.

STATOR

The stator insulation is checked by connecting the megohmmeter ground lead to the alternator frame and the other lead to the stator winding being tested. Be sure insulation resistance of the line cables is not included.

DISASSEMBLY AND OVERHAUL

GENERAL INFORMATION

The alternator assembly should be removed from the locomotive and overhauled, using approved materials and procedures, at intervals specified in the Scheduled Maintenance Program.

Overhaul consists of 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.

REMOVING ALTERNATOR STATOR

To remove the alternator stator from the generator frame, proceed as follows:

1. Remove generator coupling disc or alternator stator closure assembly, if required.
2. Properly support alternator stator. If the unit has ventilating openings around the stator frame, place a steel cable through the top two ventilating openings. Support the alternator with a suitable crane, but do not apply too much tension as some stator frames are constructed of cast aluminum and could crack.
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. Ensure against damage to laminations or windings.

REMOVING ALTERNATOR ROTOR

Perform the following procedure to remove the alternator rotor from main generator after the alternator stator has been removed:

1. Disconnect leads to the rotor field at collector ring terminal post.
2. Remove nuts or bolts connecting rotating field of alternator and adapter to main generator rotating field.
3. Support rotor using a sling as shown in Fig. 8.
4. Place jacking screws in the holes provided, and remove rotor assembly.

ROTOR OVERHAUL

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

WET METHOD

Using a prepared alkaline cleaner solution and pressure gun, "steam clean" the rotor assembly. Ensure cleanliness under coil leads. If necessary, clean with a bristle brush, and inspect for any visual damage. When assembly is clean, rinse

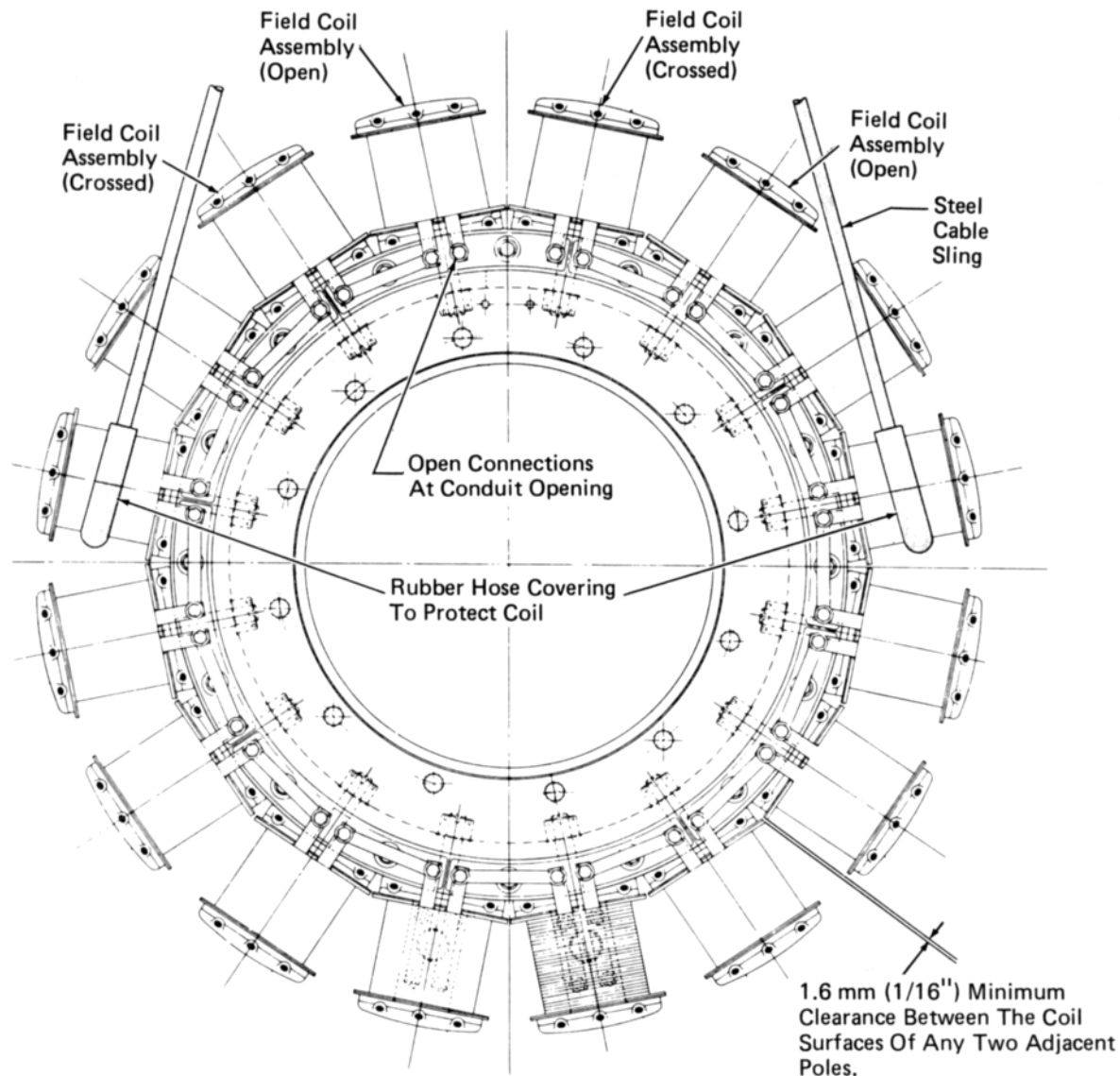


Fig. 8 - Alternator Rotor Assembly

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thoroughly with steam and water to remove all alkaline residue.

DRY METHOD

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

When using this method, care should be exercised to ensure against damage to the varnish insulation caused by prolonged application of the blast material. Therefore, the pressures used should be between 300 to 400 kPa (45 to 60 psi).

Check for loose poles as follows:

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 area between pole piece and spider. A "rust-like" substance indicates a fretting condition.
3. A bump test is performed by bumping the pole piece (not insulation or coil) with a copper bar or lead mallet while, at the same time, holding a finger at the point between the pole and the spider. Looseness is indicated by movement at this point. See "Repair Recommendations" if any loose pole pieces are found.
4. Apply insulation resistance test to field winding circuit with a megohmmeter. Circuit should read 15 megohms minimum. If 15

megohms or more, apply a high potential test to ground at 1000 volts for ten seconds. If the megohmmeter readings are less than 15 megohms, the rotor assembly should be baked in an oven set at $130^{\circ} \pm 10^{\circ} \text{ C}$ ($266^{\circ} \pm 18^{\circ} \text{ F}$) until dry to remove any moisture which may be causing the low readings.

Repeat test when the rotor assembly reaches room temperature. If the megohmmeter reading is 15 megohms or more, proceed with high potential test as above. If the readings are below 15 megohms, disconnect the connector straps in order to free the coils from each other, and locate the coil or coils with the low readings. Replace with serviceable coil(s).

NOTE: The connector blocks have unusual insulation resistance characteristics; this must be considered when interpreting megohmmeter readings. If a megohmmeter reading of less than 15 megohms is obtained 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 coils to the blocks, and perform the hi-pot test. Refer "Hi-Pot General Information" prior to performing test.

REPAIR RECOMMENDATIONS

1. If there are any broken 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 pole stud nut to a minimum of 170 N·m (125 ft-lbs). Rap the pole piece head sharply with a lead or copper mallet, and again torque each pole stud nut to 170 N·m (125 ft-lbs).

To replace a pole piece assembly, proceed as follows:

1. Remove the defective pole assembly.
2. Install proper new pole assembly. (There are eight open and eight crossed alternator field coil assemblies, Fig. 8.) These field coil assemblies should be installed so no two like assemblies are adjacent. The use of new studs, washers (where used), and nuts complete

installation of the new pole assembly. Apply white lead to studs at the time of installation. Make a polarity test. No two adjacent coils should have the same polarity.

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.

3. 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.
4. Torque each pole stud nut to 237 N·m (175 ft-lbs).
5. Swing a copper or lead bar or mallet weighing approximately 6 kg (13 lbs) from a distance of approximately 600 mm - 800 mm (24" - 30"), and sharply strike pole piece head to drive pole against armature. Strike once near each end, and once in the center.
6. Back off pole stud nuts to a maximum of 136 N·m (100 ft-lbs) and retighten to 170 N·m (125 ft-lbs).
7. It is recommended that the cables to field coils be replaced whenever the rotor is being overhauled.
8. 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).
9. High potential test the entire field coil circuit to ground at 1000 volts AC, 60 Hz, for 5 seconds.

If all new field coils and cables have been installed, high potential voltage should be increased to 1400 volts for 5 seconds.

WARNING: Insulate the ends of the two cables to prevent injury to personnel.

10. Resistance test entire field coil circuit at 1000 VAC for 10 seconds.

11. Paint inside of spider, plate, and conduit with red air drying enamel.

Take care to keep varnish off all finished surfaces.

STATOR OVERHAUL

The alternator stator is wired as shown in Fig. 9. Three adjacent coils constitute a group. The numbers shown indicate the slot number in which the high side of the first coil in each group lays.

The four parallel legs of each phase are separately lugged, stamped, and brought out to a terminal board.

Series connections, between the finish of one coil and the start of the next, are made by laying the two ends together and soldering a tinned copper clip around them with pure tin solder.

Using the "Dry Method" cleaning procedure, prepare stator for varnish treatment after removal.

Ensure a megohmmeter reading of a minimum of 2 megohms is obtainable by applying an insulation resistance condition test to the stator winding. If megger registers below 2 megohms, bake stator in an oven set at 125° C (257° F) for 4 hours, to remove any moisture. If minimum

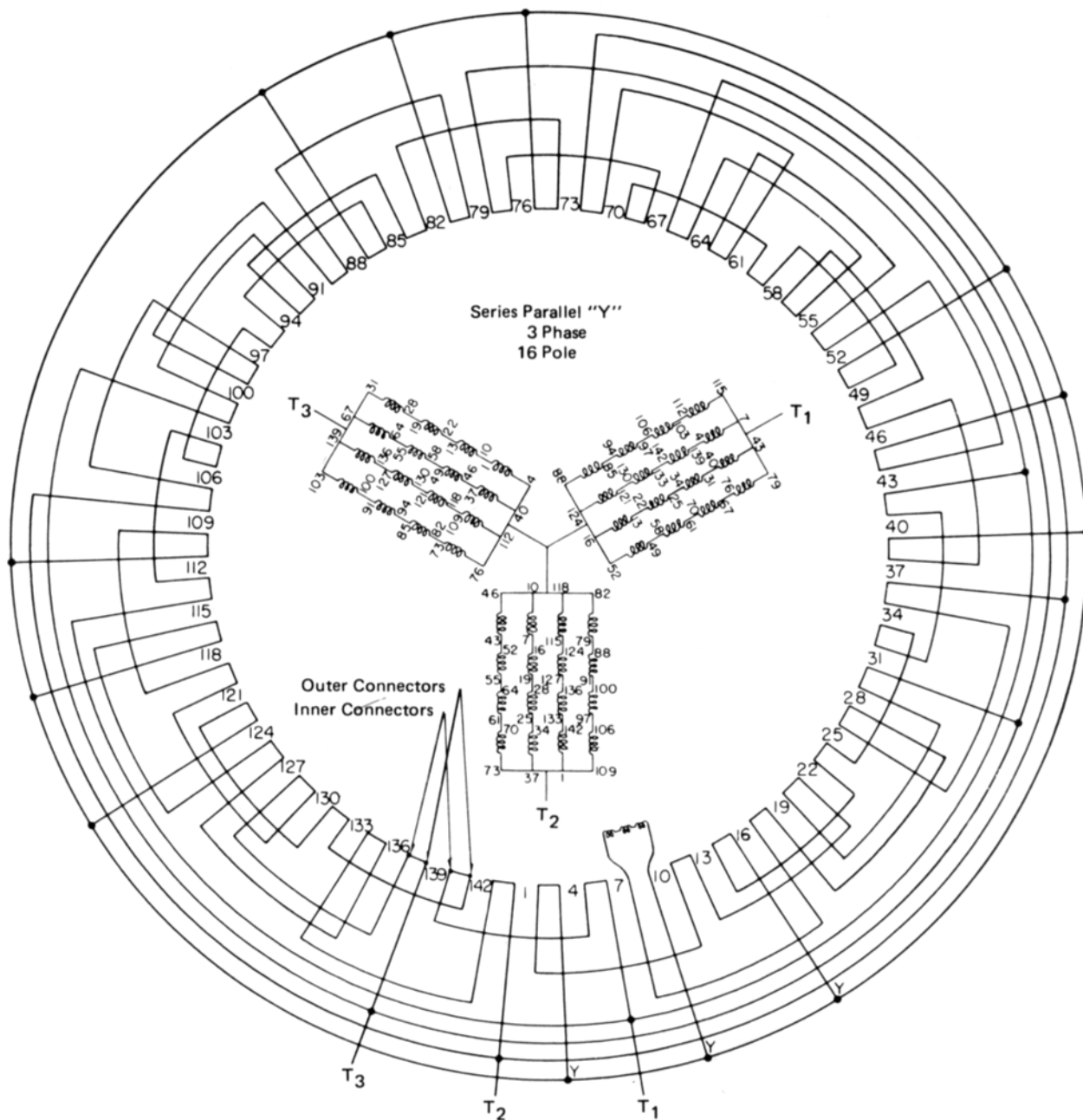


Fig. 9 - Alternator Stator Wiring Diagram, D14 Alternator

reading of 2 megohms is obtained, proceed with a high potential test to ground at 1000 VAC, 60 Hz for 10 seconds.

See Service Data for the phase-to-phase resistance test between terminals 1 and 2, 2 and 3, and 1 and 3, Fig. 10.

VARNISH TREATMENT

ROTOR ASSEMBLY

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

Drying And Preheat

1. Heat rotor in a convection oven to $130^{\circ} \pm 10^{\circ} \text{ C}$ ($266^{\circ} \pm 18^{\circ} \text{ F}$) and maintain for 2 hours minimum.
2. Remove rotor from oven and megger test immediately. If megger reads 2 megohms or more, proceed with "Dip and Bake" operations. If rotor tests below 2 megohms, perform "Repair Procedure" given below.

Dip And Bake

1. Dip rotor at $100^{\circ} - 120^{\circ} \text{ C}$ ($212^{\circ} - 248^{\circ} \text{ F}$) in varnish thinned with a solvent blend of 80% Rule 66 Mineral Spirits and 20% Butyl Acetate. Allow to soak in varnish bath for 5 minutes.
2. Remove rotor from varnish and allow to drain for 5 minutes.
3. Clean varnish from mounting surfaces using a solvent saturated cloth.
4. Bake rotor for 5 hours in an oven set not to exceed 160° C (320° F).

The finished rotor assembly must measure 15 megohms minimum at room temperature.

Repair Procedure

1. If rotor does not meet the 15 megohms minimum requirement after varnish treatment, disconnect coil leads and check for defective coils. Individual coil resistance to ground should be 250 megohms minimum.

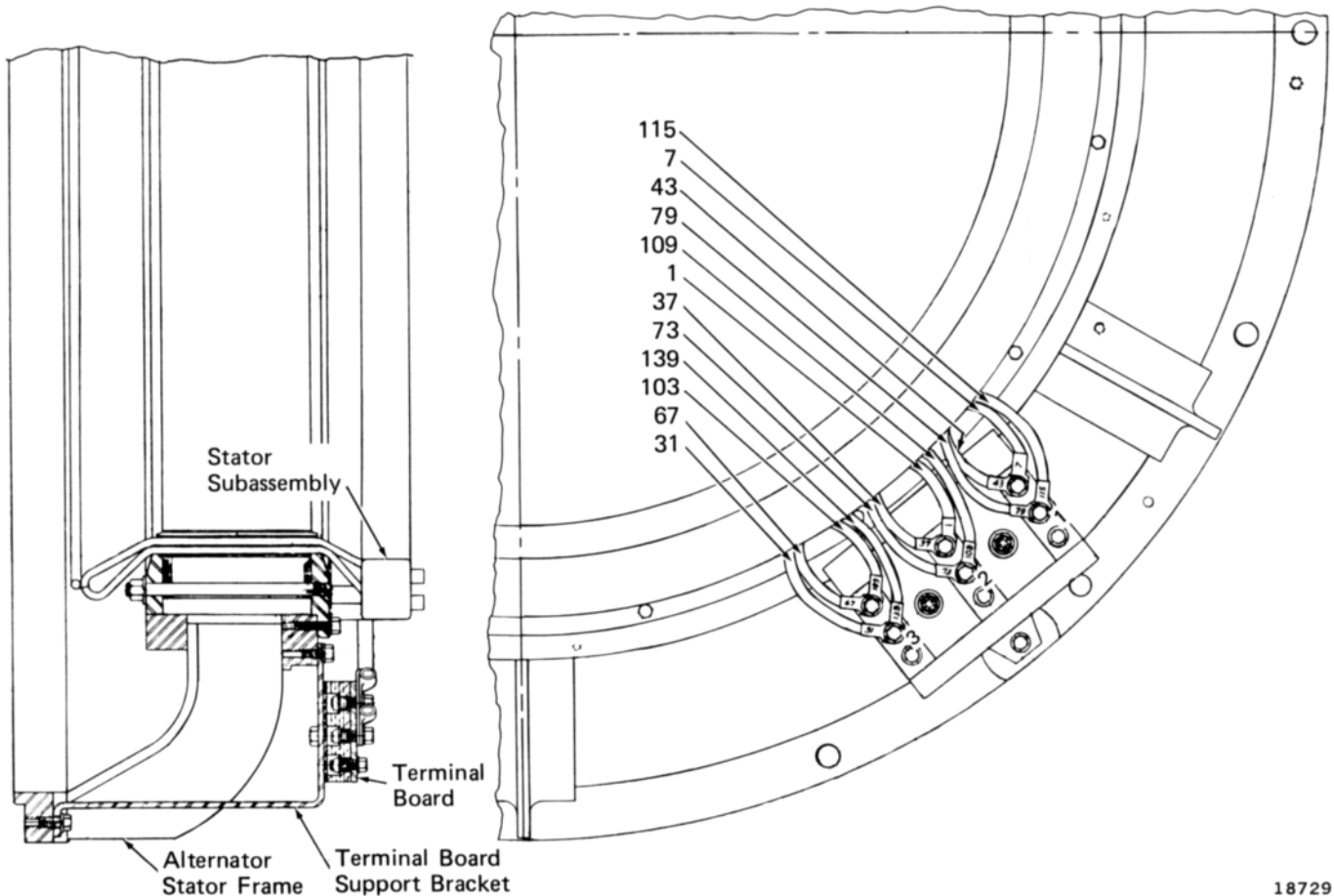


Fig. 10 - Alternator Stator Terminal Assembly

2. Repeat varnish treatment if old coils are used for replacement. When new coils are used, varnish treatment repetition is not necessary.

STATOR ASSEMBLY

Remove stator subassembly from stator frame by using 3/16" NC bolts in the tapped holes on the flange.

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

Stator assemblies which pass the inspection and electrical tests, or those that have been reworked as needed and have met the prescribed inspection and tests, should be varnish treated as follows:

Drying And Preheat

Preheat stator for 2-1/2 hours in a convection oven preset to 160° C (320° F). The average copper and steel temperature for dipping should be 105° to 115° C (221° to 239° F).

Dip And Bake

1. Remove the hot stator assembly from the oven, and immerse in varnish for 5 minutes. (Stator should be dipped within 10 minutes from time it is removed from oven.)
2. Remove stator from varnish and allow to drain for 5 minutes.
3. Re-dip stator in varnish for 2 minutes to build up varnish thickness.
4. Remove stator from varnish and drain for 10 minutes.
5. Preset oven temperature to 175° C (347° F).
6. Return stator assembly to oven, and bake for 4 hours. The average copper and steel temperatures should be 165° C +10° C -5° C (329° F +18° F -9° F) at the end of bake cycle.
7. Clean varnish from all machined surfaces, tapped holes, and mounting pads immediately after oven-bake while stator remains hot and varnish is soft.

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 which should be incorporated in the tester, the following points are pertinent: Wave form, surges, and voltage regulation.

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 RMS voltage.

Wave form 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.

SURGES

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

REGULATION

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

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.

SERVICE DATA

SPECIFICATIONS

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	19.05 mm (3/4") on long side

Resistance @ 75° C

D14 Stator, phase-to-phase01005 ± 4.0%
D14 Rotor, slip-ring to slip-ring	2.21 ± 3.7%

Maximum variation in resistance allowable

between any two phases on D140001 ohm
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Air Gap (nominal)

D14	3.97 mm (.156")
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Weights (Approx.)

D14 Rotor	680 kg (1500 lbs)
D14 Stator	422 kg (930 lbs)

MISCELLANEOUS

- *Varnish, Electrical Insulating - Modified Polyester Y-432 (Sterling Varnish Co.)
Varnish mixture to have viscosity at 250-325 seconds using Ford Cup No. 4 at 21.1° C (70° F).
Thinner Solvent For Above Varnish
Chevron No. 1300 Solvent
Thompson - Hayward Chemical Company No. 2026 Solvent
- **Xylol Thinner

An alternate thinner solvent may be blended using the following materials:

- Mineral Spirits (Rule 66 Type Thinner) 80%
- Butyl Acetate - Technical Grade 20%

NOTE: The above blend is required because the varnish sets up in the tank when mineral spirits thinner is used alone. Butyl acetate prevents this.

- * 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.

