EMD MAINTENANCE INSTRUCTION

ALTERNATING CURRENT GENERATORS TYPES D14, D14A AND D16

DESCRIPTION

Alternators are used on locomotives to provide an efficient method of driving such important auxiliaries as engine cooling fans, traction motor blowers and ventilating fans. The alternating current power generated drives such devices through directly connected, highly efficient induction motors.

The construction, operation and maintenance of the D14, D14A and D16 alternators are almost identical; thus the information contained in this bulletin will apply to all of them unless differences are specifically indicated.

Alternator types D14 and D14A are rated at 100 KVA at 0.8 power factor. They are 3-phase machines, Wye (Y) connected and have 16 poles. The D14 alternator is built integral with the D12 main generator as shown in Fig. 1. The D14A alternator is built integral with the D8B main generator.

The type D16 alternator is built integral with the D15 or D15B main generator. It is a 16-pole, 3-phase machine, Wye (Y) connected and is rated at 50 KVA at 0.8 power factor.

When driven by the engine at 800 RPM, these alternators produce approximately 149 volts at 106-2/3 cycles per second. On applications driven at 835 RPM they produce approximately 170 volts at 111-1/3 cycles per second. The field current of the alternators is set to produce the desired voltage by means of an external resistor located in the locomotive electrical cabinet.

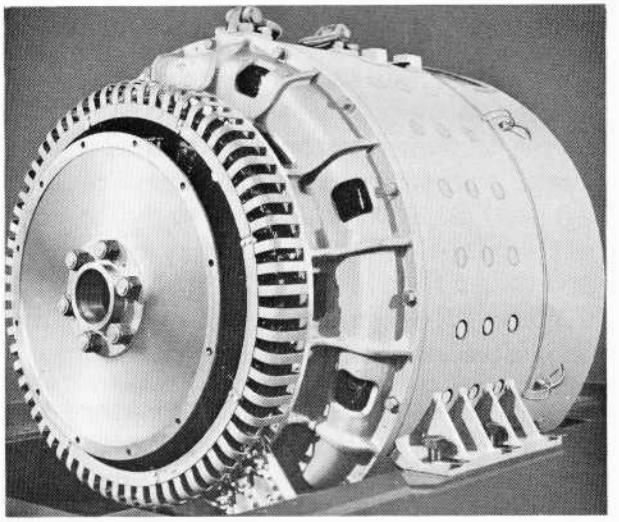

Fig. 1 - D14 Alternator With D12 Main Generator

The alternator stator assembly is bolted directly to the main generator frame. The rotor or rotating field assembly is bolted on one end to the main generator armature spider and on the other end to the engine by means of a disc type coupling. Thus connected, the alternator becomes an integral part of its associated main generator.

ROUTINE MAINTENANCE

The alternator should be cleaned and inspected at intervals specified in Scheduled Maintenance Program Maintenance Instruction 1704, or more frequently if conditions require.

CLEANING

Electrical equipment should not be sprayed or cleaned with a liquid of any kind. Attempting to clean the coils and

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windings with a liquid cleaner will destroy the protective coating, causing it to peel or crack.

Dry compressed air at low pressure (30 to 50 pounds) may be used to blow out dirt from the stator and rotor assembly. 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 fibre scrapers may be used. In SEVERE cases only (to prevent surface creepage) it may be necessary to DAMPEN a cloth in solvent such as alcohol to remove the dirt from rotating field terminals and connectors.

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

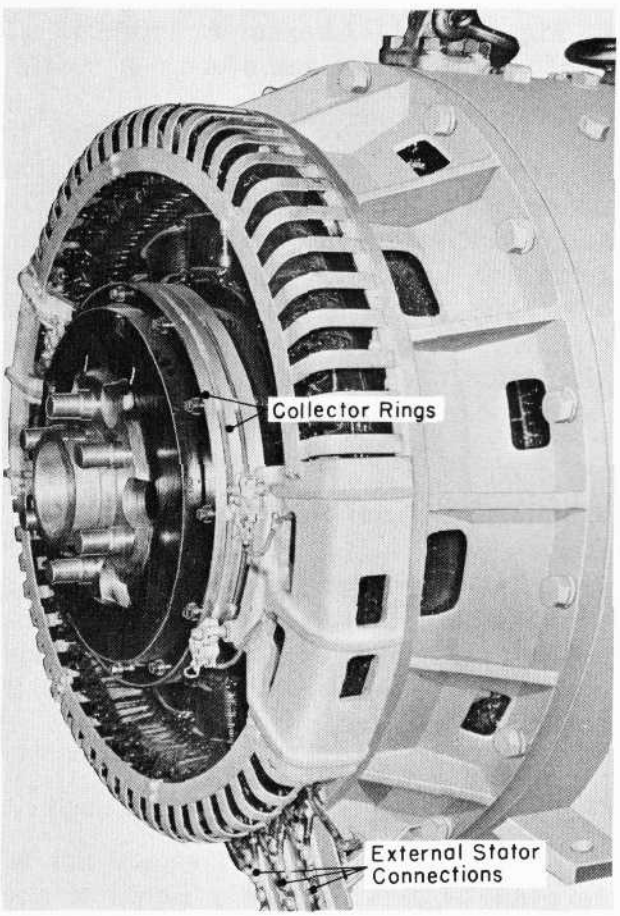

Fig. 2 - D14A Alternator

INSPECTION

Cables And Terminal Boards

All cable connections to brush holders and terminal boards should be checked for tightness. Fig. 2 illustrates the external stator connections that should be inspected as well as the cables leading to the brush holders. Using dry cloths, wipe away any accumulations of dirt.

Collector Rings (Slip Rings)

The collector rings used on the D14A alternator, Fig. 2, consist of two insulated bronze rings bolted to a steel flange on the rotor spider.

On D14 and D16 alternators, the collector rings consist of two insulated bronze rings shrunk in place on an insulated sleeve of the alternator collector ring assembly as shown in Figs. 3 and 4.

Collector rings should be kept clean by wiping with a dry cloth or crocus cloth as necessary. It is also important to maintain cleanliness in the creepage surface between the rings using a clean brush and wiping with dry cloths.

Collector ring eccentricity with the shaft should not exceed .006" total indicator reading. If removed, rings are reinstalled by heating to 190° C. and shrinking in place on the collector ring assembly. The horizontal runout should not exceed 1/32" total indicator reading.

In case of bad burns or scoring, the collector ring assembly should be placed in a lathe and ring faces turned and polished.

Grinding Collector Rings
(Generator In Locomotive)

When rings are burned, pitted or worn eccentric with the shaft, the ring

face can often be returned to satisfactory condition by grinding. Fig. 5 shows the application of grinding fixture 8176873 which is used with coarse stone 8209151 and finishing stone 8209152. The following procedure is recommended:

1. Prevent alternator excitation by removing the 35-ampere alternator field fuse or opening the circuit breaker on locomotives so equipped.
2. Prevent the main generator from developing power by removing the battery field fuse.

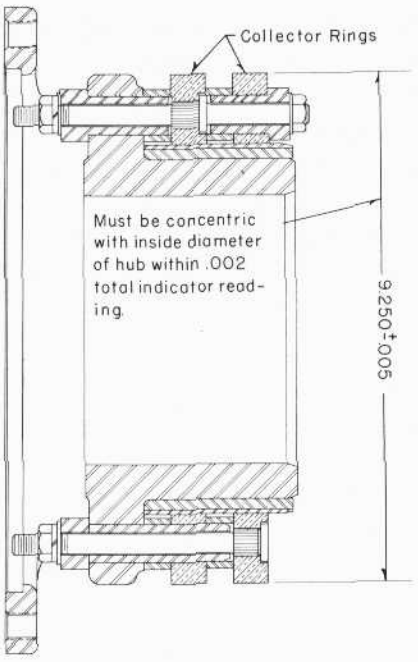

Fig. 3 - D14 Alternator Collector Ring Compressor Coupling Adapter Assembly

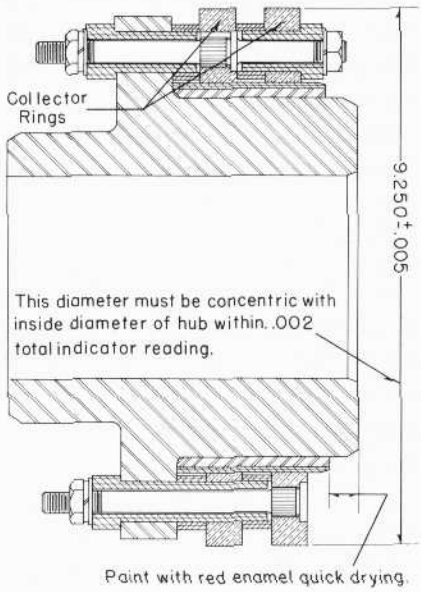

Fig. 4 - D16 Alternator Collector Ring Assembly

3. Remove the two brush holders on the right hand side when facing collector rings. Install grinding fixture, bolting it to brush holder post.

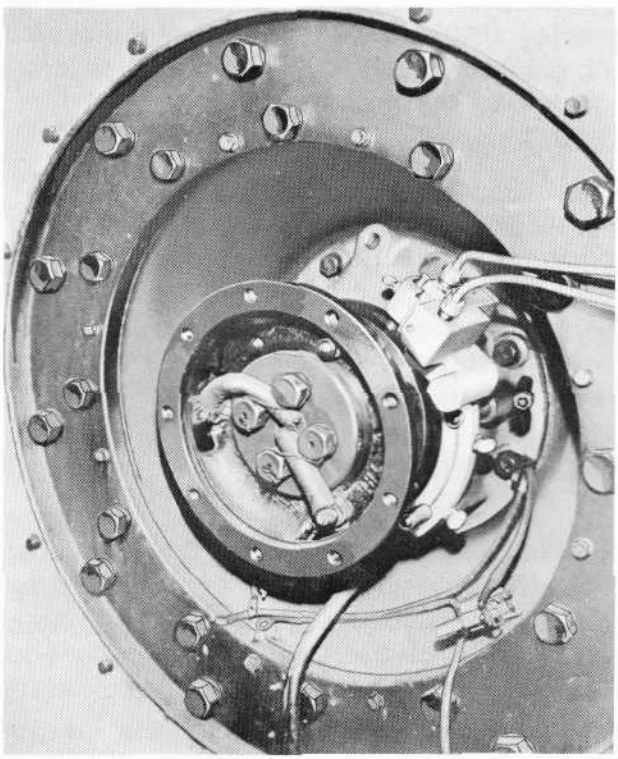

Fig. 5 - Application Of Collector Ring Grinding Fixture

4. Start engine and run at idle speed.
5. Grind collector rings with coarse stone and complete work using finishing stone.
6. After grinding remove fixture and clean all surfaces of grinding dust. Replace brush holders and brushes. Refer to brush holder section for proper positioning of this assembly.
7. Restore circuits for normal operation.

Brush Holders

There are two brush holders per collector ring and those of like polarity are connected together. On D14 and D16 alternators, the brush holders are held by insulated studs pressed into the main generator bearing cover. On D14A alternators brush holders are held on brackets which are bolted to the stator frame.

Brush holders should be checked for security of mounting and proper positioning with respect to the collector ring. Referring to Fig. 6, maintain 1/8" clearance between the bottom of each brush holder and the associated collector ring.

When making brush holder to terminal board connections, make sure the two cables from one terminal on the board lead to brush holders on the same collector ring. If this precaution is not taken, the auxiliary generator will be short circuited when engine is started.

Brushes

Brushes should be checked for freedom of movement by releasing the springs and raising and lowering them in their carbonways to release any accumulated dirt that may cause them to stick or bind. Use care not to snap the springs which may break or chip the brushes. Observe that brushes maintain a full surface contact on the collector rings.

Replace worn brushes with new ones of the same type. Using different grades of brushes on the same machine is likely to be detrimental to successful operation.

New brushes should be "sanded in" using a fine grade of sandpaper. Place sandpaper under brush and carefully pull it, following the collector ring surface. Repeat as necessary by first lifting the brush to again start the sandpaper strip. Care should be taken to prevent rounding of brush edges.

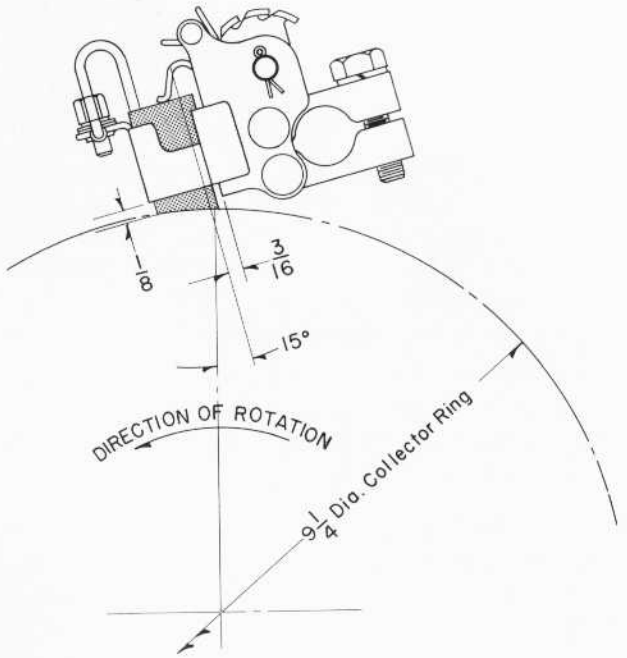

Fig. 6 - Brush Holder Assembly

Brush spring pressure should be checked and adjusted if necessary to maintain the recommended spring pressure of 1 to 1-1/2 pounds. Adjustment is made by changing the spiral spring tension, usually the first of the three adjusting slots. It is important that all brushes have the same spring pressure to prevent unequal current distribution.

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 rotor spider 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.

High Potential Tests

After qualifying insulation resistance as being satisfactory from the foregoing test, the rotor and stator are each to be given a high potential test. Refer to Maintenance Instruction 2100 for procedure to be used and precautions to be taken when using the hy-pot machine.

For purposes of this test, the alternator may be considered a high voltage machine thus test voltages should be the

same as those specified for other high voltage equipment.

Alternator Field Setting

The alternator field resistance has been properly set at the time of manufacture and no changes should normally be necessary other than when the resistor has been replaced.

If the resistor has been replaced, the following steps are necessary to make a proper setting:

1. Before starting engine, adjust the resistor for approximately 2 ohms for a cold setting.
2. Start engine and while idling check alternator voltage with an AC voltmeter. Voltage reading should be approximately 55 volts with meter connected across any two stator leads at the terminal board or across the NVR relay coil.
3. With full engine speed (800 or 835 RPM) and with all traction motor blowers operating and two cooling fans running, measure the AC voltage as in Step 2. The voltage should be 149 volts at 800 RPM or 170 volts at 835 RPM depending on installation.
4. If the voltage is not satisfactory, then the alternator field resistor must be adjusted accordingly.

CAUTION: Shut down engine before making any adjustments of the alternator field resistor.

OVERHAUL MAINTENANCE

It is recommended that the alternator assembly be removed from the locomotive and overhauled using approved materials and methods at intervals specified in the Scheduled Maintenance Program, Maintenance Instruction 1704.

Overhaul consists of careful inspection of all components such as the rotor, stator and collector ring assemblies and the replacement of worn or defective parts. In addition it includes thorough cleaning, varnish treatment, and the application of the required tests, all of which will restore the alternator to the condition necessary for it to perform satisfactorily to the next overhaul period.

Of primary consideration is the insulation which even under normal service will gradually deteriorate with age from dirt, heat and moisture. The rate at which insulation deteriorates is determined to a great extent by the service and care to which it is subjected. The total useful life can be increased by keeping insulation clean and dry.

Removal Of Alternator Stator From Main Generator Frame

After the alternator-main generator assembly has been removed from the locomotive, the alternator stator may be removed from the main generator frame by the following method:

1. Remove generator coupling disc if it is on the rotor.
2. Remove brushes from collector rings.
3. Place a steel cable through the top two ventilating openings in the stator frame. Pull the cable tight using a suitable crane but be careful not to use too much tension as some stator frames are cast aluminum and are likely to be cracked.
4. Remove bolts holding alternator stator frame to main generator frame.
5. Apply three 1/2"-13 jacking bolts to the tapped holes provided in the stator frame, and turn up evenly taking care to avoid binding.
6. Remove stator over rotor poles taking care to prevent damaging laminations or windings.

Rotor Removal From D14 And D16 Alternators

The procedure below should be followed in removing rotors from D12 and

D15 main generators after the stator has been removed:

1. Disconnect leads to the rotor field at collector rings and remove cable tie, lugs, steel flange and fibre bushings.
2. Remove nuts or bolts connecting rotor spider and adapter to armature spider.
3. Support rotor using a sling as shown in Fig. 7.
4. Place jacking screws in the holes provided and remove rotor assembly.

NOTE: It is unnecessary on the D14 to mark the rotor position on the armature for purposes of balance since the studs are arranged in such a way that the rotor can be assembled to the armature in only one position.

Rotor Removal From D14A Alternators

When working with a D8B main generator, after the stator has been removed, the rotor can be removed by following the procedure below:

1. Remove main generator armature and alternator rotor from the main generator housing as a complete unit and place assembly in a vertical position, commutator end down.
2. Place mating chisel marks at some convenient point on the rotor spider and armature spider which will be used on reassembly to preserve assembly balance.
3. Remove coupling bolts connecting rotor spider to armature spider. Enlarged holes have been provided in the rotor through which a socket on an extension handle may be used to remove the bolts. No jack screw holes are provided however a screw and a plate may be used between the stud shaft of the armature and rotor spider to free the rotor from its press fit.

Rotor Overhaul

After separating the alternator rotor from the direct current armature, the rotor should be cleaned to remove all dirt and grease. Clean as outlined under "Stator Overhaul." Then a check for loose poles should be made 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. Fretting between the pole piece and spider will be evident by a "rust" like substance working out from between the pole piece and spider. This can be seen on close examination.
3. Bump test. This is accomplished by bumping the pole piece (not insulation or coil) with a copper bar or lead mallet while at the same time holding the finger at the point between the pole and the spider. Looseness will be indicated by movement at this point. See repair recommendations if any loose pole pieces are found.
4. Apply an insulation resistance condition test to the field winding circuit with a 500 volt megohmmeter. Field circuit should "meg" 2 megohms minimum. If the megohm readings are less than 2 megohms, the rotor assembly should be baked in an oven set at 125° C. for 4 hours to remove any moisture which may be causing the low readings. Recheck megohm readings after cooling rotor to the temperature of the last test for a comparison value. If the megohmmeter readings are 2 megohms or more, proceed with a high potential test to ground at 1000 volts AC, 60 cycles for ten seconds.

   If the readings are low after baking, disconnect the connector straps in order to free the coils from each other and try to locate the coil or

coils with the low readings. After the faulty coil is found, this coil should be removed from the assembly. The pole studs should be worked back and forth in order to free the anchor pin. After the anchor pin is free, the faulty coil should again be baked as outlined in Step 4. After the coil has cooled, recheck with a megohmmeter. It has been found when a pole and coil have been treated in this manner, the insulation resistance would come up to infinite megohm reading.

NOTE: There are two types of D14 rotors:

1. Those having the coil terminals bolted to a connector block (new style), shown on Fig. 7.
2. Those having the coil terminals connected directly to a copper connector strap (old style).

All D16 rotors are of the new style with a connector block as shown in Fig. 7.

In the case of the new style rotors (both D14 and D16) the connector blocks have unusual insulation resistance characteristics; this must be borne in mind in interpreting megohmmeter readings obtained with the new style rotors. If the megohmmeter reading of less than 2 megohms is obtained on a clean rotor of the new style, the coil terminal should be disconnected from the block and the

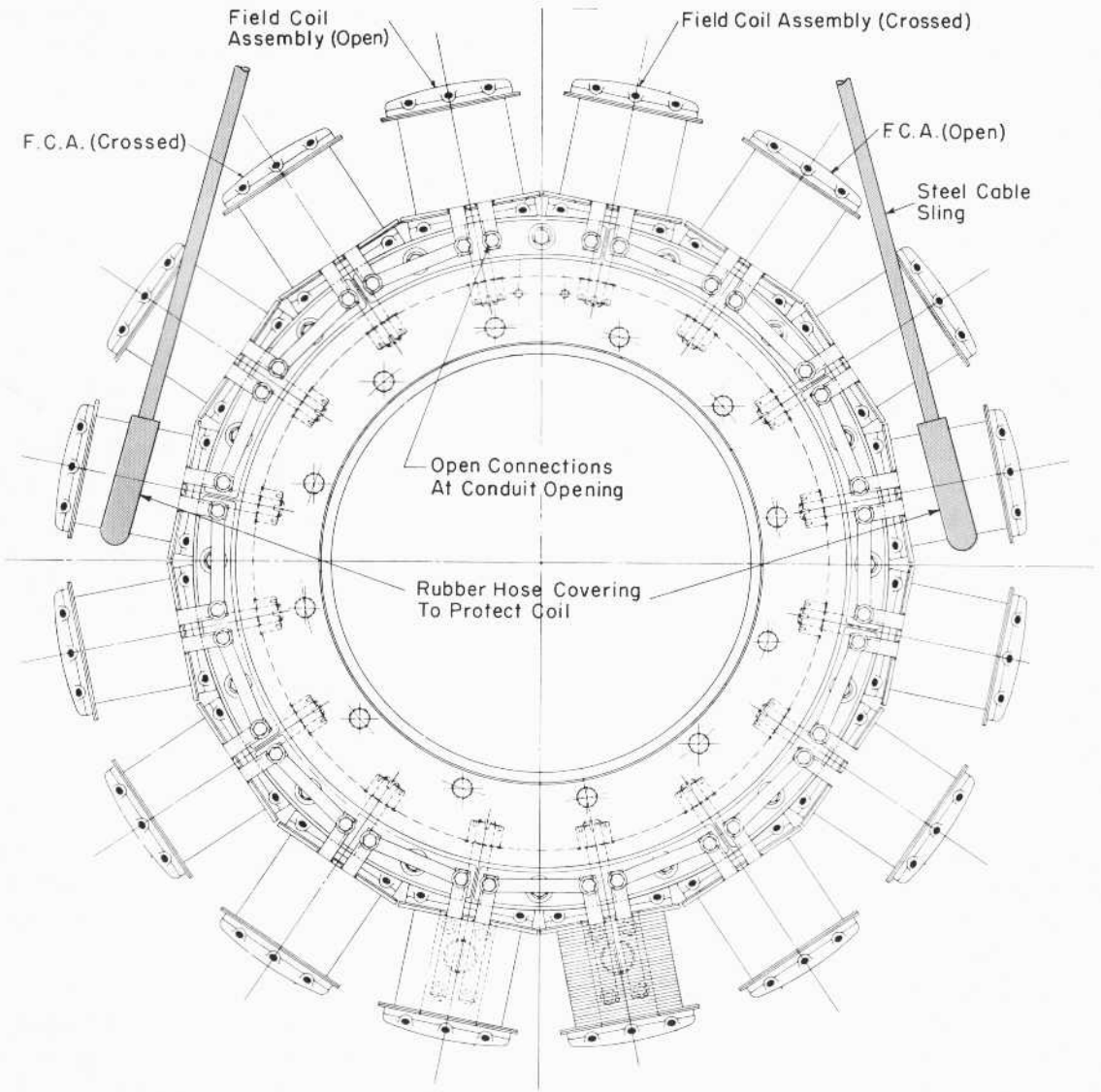

Fig. 7 - Alternator Rotor Assembly

individual coils meggered to ground. Individual coil readings should be infinity, and if so, the coils may be reconnected to the blocks and the usual high potential test performed.

Refer to Maintenance Instruction 2100 for precautions before making high potential test.

Repair Recommendations

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

2. To tighten rotor pole assembly bolts remove lockwire and torque each pole stud nut to a minimum of 125 foot-pounds. Rap the pole piece head sharply with a lead or copper mallet and again retorque each pole stud nut to 125 foot-pounds. If lockwire holes in pole stud do not line up, tighten to next castellation on nut.

3. In the early manufacture of D14A alternator rotors, the rotor spider wall was machined thin Therefore, in order to prevent the pole stud nuts from running out of the thread on the studs and to have the castellations of the nuts align with the lock wire holes in the studs, it was necessary to place under each nut, in addition to the three-hole washer, one individual flat washer 106267. In the event that any of the above rotors are being overhauled and have broken studs, it will be necessary to renew the three-hole washer and the flat washers and tighten the poles as noted in Steps 1 and 2.

When necessary to replace a pole piece assembly because of damaged coil or other reasons, 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. These field coil assemblies should be installed so that no two identical assemblies are adjacent. Install new pole assembly complete with new studs, washers where used, and nuts. 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 a new pole assembly is being installed, it will be advisable to try to match the weight of the pole being replaced as close as possible in order to simplify balancing.

3. Check poles for spacing and parallelism before installing lockwire. Measure the distance between poles, on the sides of the laminations, half way between the brass end pieces. A variation of 1/32" between maximum and minimum readings is allowed on this dimension. Pole axes should be parallel with the main rotor axes within 1/32" in the length of the laminations.

4. Torque each pole stud nut to 175 foot-pounds.

5. Sharply strike pole piece head (once near each end and once in the center) to drive pole against spider, using a 13 pound (approximately) copper or lead bar or mallet, swung 24 to 30 inches.

6. Back off pole stud nuts to a maximum of 100 foot-pounds.

7. Retighten to 125 foot-pounds. If lockwire holes in the pole studs do not line up, tighten to next castellation on nut. The pole stud nuts should always have a minimum of 125 foot-pounds.

8. Install two strands of soft iron lockwire twisted together between like studs of adjacent poles.

9. Bolt on connectors with electro-tin plated bolts, nuts and flat washers. Connector should be installed on the inner or shaft side of the coil terminals. Solder joints with tin base solder.

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

11. Whenever a pole assembly has been removed, or one or more new poles have been replaced, the rotor assembly must be dynamically balanced.

12. High potential test the entire field coil circuit to ground at 1000 volts AC, 60 cycles for 5 seconds.

NOTE: High potential voltage should be increased to 1400 volts for 5 seconds if all new field coils and cables have been installed.

Care should be exercised to insulate the ends of the two cable assemblies so that they cannot provide a circuit to ground, and so that personnel will not be injured by coming in contact with their loose ends.

13. Resistance test entire field coil circuit. The resistance value of the field circuit should be as noted when corrected to 75° C.

Rotor
D14 & D14A - - - - 2.21 $\pm$ 3.7% ohms

Rotor
D16 - - - - - - - - 3.16 $\pm$ 3.5% ohms

14. Paint inside of spider, plate and conduit with black air drying varnish.

Take care to keep varnish off all finished surfaces.

Varnish Treatment Of 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.

Place assembly in oven for four hours with the temperature set at 125° C.

Remove from oven, and while hot, dip in clear baking varnish 8136692 thinned with xylol 8089758 to maintain viscosity of the varnish at 40 - 55 seconds Ford Cup #4 at 21.1° C. Allow to soak for five minutes.

Remove from the varnish and allow to drain for five minutes. Clean varnish from all machined surfaces using a cloth saturated with xylol.

Place in oven set for 125° C. and bake for two hours.

After baking remove from oven, and while hot (50° $\pm$ 5° C.), make a hy-pot test to ground using 1000 volts for 5 seconds.

Stator Overhaul

The alternator stator is wired as shown in Fig. 8. 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.

After removal, clean stator assembly to remove all carbon dust, grease and dirt. Granulated corn cob material applied with a controlled air blast has been found to be a satisfactory method for cleaning and degreasing of electrical equipment and insulation because it produces a clean dry, oil free surface suitable for immediate varnish treatment.

Care should be exercised when using the corn cob method as it is possible to remove the varnish and cut into the layers

of insulation by prolonged application of the blast material. The pressures used with this method of cleaning are from 45 to 60 pounds per square inch.

Apply an insulation resistance condition test to the stator winding. If the megohmmeter readings are below 2 megohms, the stator should be baked in an oven set at 125° C. for 4 hours to remove any moisture. If the megohmmeter readings are 2 megohms or more, proceed with a high potential test to ground at 1000 volts AC, 60 cycles for 10 seconds.

Phase-to-phase resistance test between terminals 1 and 2, 2 and 3 and 1 and 3, should be as noted when corrected to 75° C. Fig. 9.

Phase-to-Phase
D14, D14A - - - .01005 ± 3.7% ohms

Phase-to-Phase
D16 - - - - - - .01985 ± 3.5% ohms

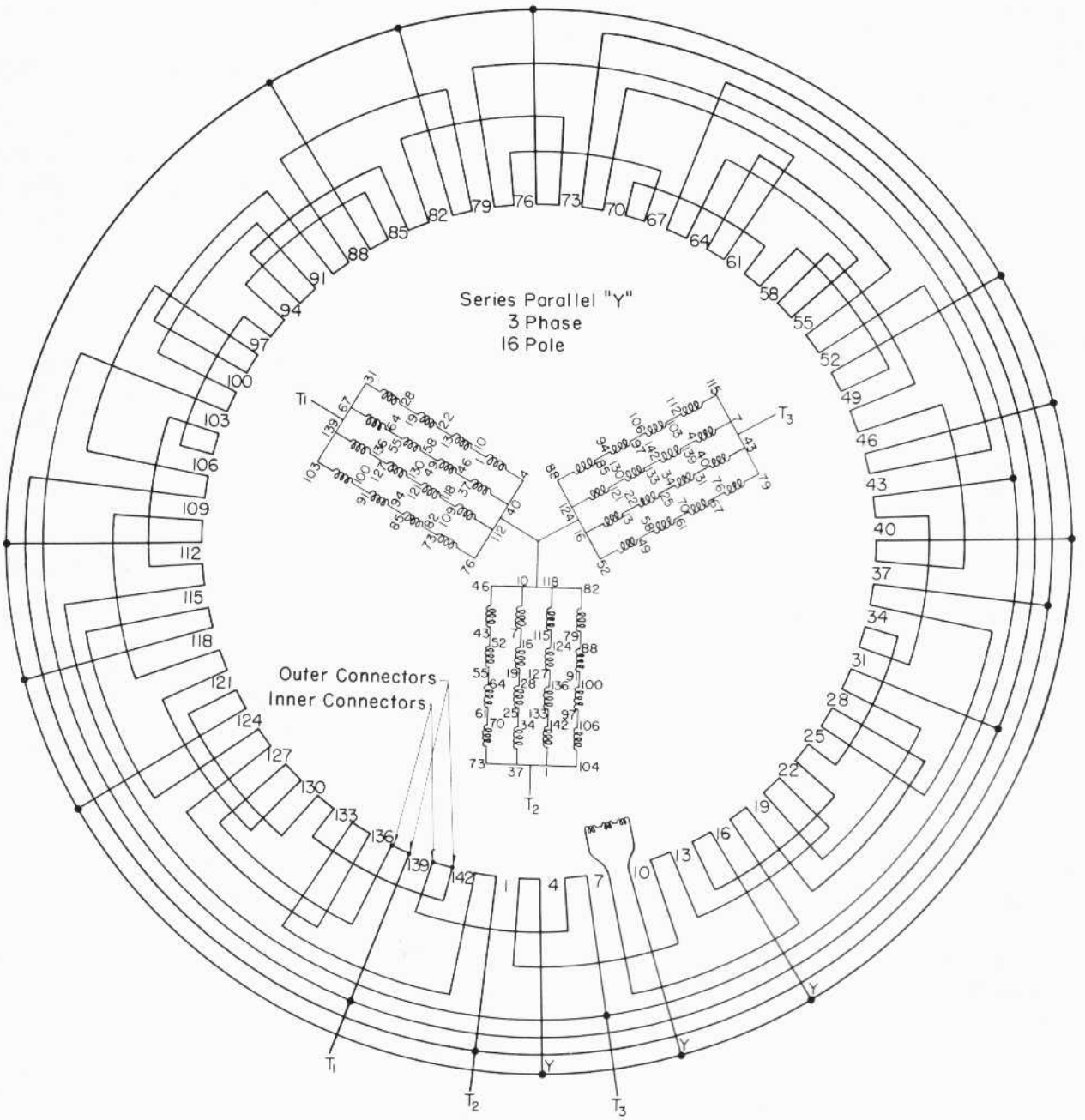

Fig. 8 - Alternator Stator Wiring Diagram D14 Generator

Varnish Treatment Of Stator Subassembly

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 have been reworked as needed and met the prescribed inspection and tests, should be varnish treated as described under Varnish Treatment of Rotor Assembly in this Maintenance Instruction.

Assembly Of Alternator Stator Subassembly Into Alternator Stator Frame

When alternator stator subassembly has cooled after final dip and bake, place the subassembly in the frame so that the holes in the flange line up with the tapped holes in the frame. It is important that the correct holes in the flange line up with the mating holes in the frame in order that the terminal board and guards will match the subassembly.

On the alternator stator frame, there is a 3/8"-16 NC tapped hole in the outside flange for mounting the terminal board support assembly. Do not confuse

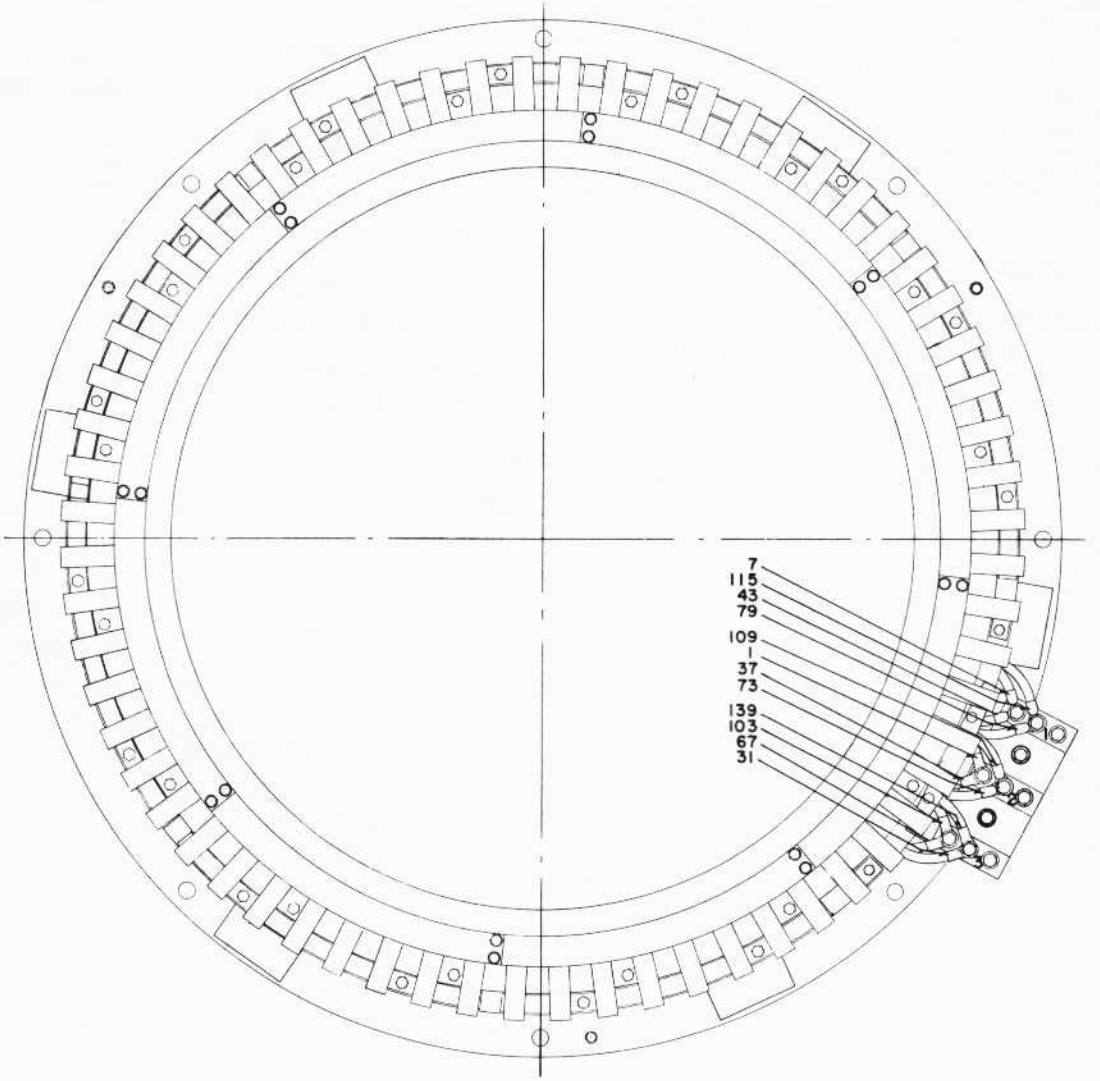

Fig. 9 - Alternator Stator Assembly

this hole with one of the three 1/2"-13 NC tapped holes in the outside flange.

After locating the stator subassembly inside the alternator frame, mount and bolt the terminal board and support assembly. Bolt the twelve lugs firmly in position on terminal board, see Fig. 9.

Bolt the seven guard segments and the special guard segment to frame. The special guard segment is applied at terminal board. Bolt guard segments together.

MAINTENANCE DATA

Brushes

Brush tension - - - - 1 to 1-1/2 lbs.

Number of brushes - - - - - - - - 4

Number of brush holders - - - - - 4

Size of brush - 3/8" × 3/4" × 1-1/2"

Brush wear limit - 5/8" on long side

D14 Resistance at 75° C.

Stator
(phase-to-phase) - .01005 $\pm$ 3.7% ohms

Rotor (ring-to-ring) 2.21 $\pm$ 3.7% ohms

Maximum variation in resistance allowable between any two phases on one machine is .0001 ohms @ 75° C.

D16 Resistance at 75° C.

Stator
(phase-to-phase) - .01985 $\pm$ 3.5% ohms

Rotor (ring-to-ring) 3.16 $\pm$ 3.5% ohms

Maximum variation in resistance allowable between any two phases on one machine is .00015 ohms @ 75° C.

Air Gap (nominal)

D14 and D16 - - - - - - - - - -.156"

Weights D14

Weight of rotor assembly - - - - 1500 lbs. (approx.)

Weight of stator assembly - - - - - 930 lbs. (approx.)

Weights D16

Weight of rotor assembly - - - - - 680 lbs. (approx.)

Weight of stator assembly - - - - - 845 lbs. (approx.)

Equipment List

Red insulating enamel (1 qt.) - #8061130
Black air-drying insulating varnish (1 gal.) - - #8122347
Pure tin solder (roll) - - - - #8107868