GM Locomotive Group

MAINTENANCE INSTRUCTION

M.I. 3319 - TRACTION ALTERNATORS WITH HEAD END POWER

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TRACTION ALTERNATORS WITH HEAD END POWER

The purpose of this document is to provide maintenance information for the AR10 traction and head end power main generator. The main generator assembly consists of a traction alternator, a head end power (HEP) alternator, and a companion alternator (D14 or CA5). The traction alternator, companion alternator, and head end power alternator are all physically connected together on the same shaft but are all electrically independent of each other.

Differences between the head end power and companion alternator models used with the AR10 traction alternator will be identified throughout this maintenance instruction.

The main generator consists of three, three-phase, alternating current generators with a single bearing. The spiders of the three machines are bolted together with the HEP alternator in the middle and the coupling disc of the companion alternator bolted to the coupling of the engine. The outboard end of the traction alternator rotor is supported by a bearing.

The rotating field of the traction alternator consist of series connected field coils wound on laminated poles, which are bolted to a drum-type spider. The spider is connected to the rotor shaft which is supported by the bearing mounted in the main generator end housing. The field coils are insulated with class "F" insulation. The traction alternator field coils are electrically connected to two inboard collector rings mounted in the air box at the bearing end of the assembly. The companion alternator (D14 or CA5) field coils are electrically connected to the middle two collector rings and the HEP alternator field coils are connected to the outboard two collector rings. The collector rings and associated brush holders provide the means of exciting the fields of the three machines.

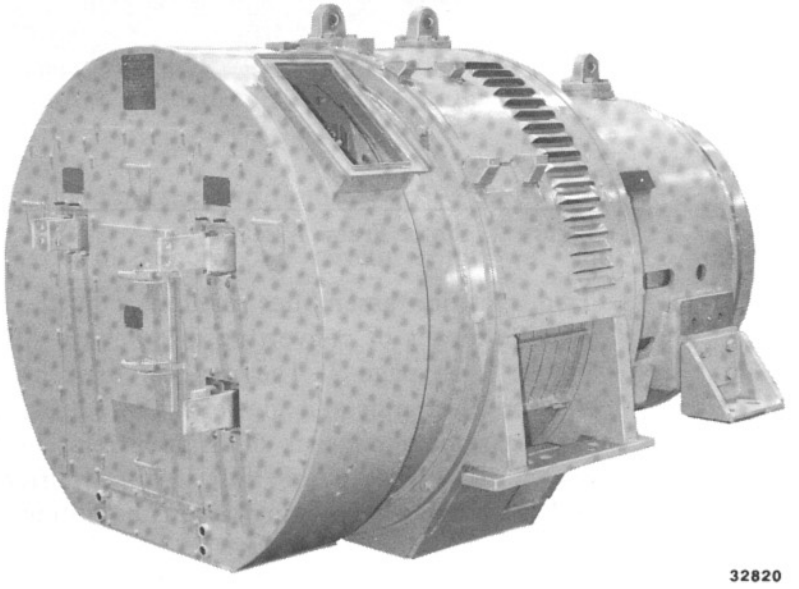

Figure 1. Typical Main Generator

The main generator has an air box cover equipped with an access door. Refer to Figure 1. The door provides easy access to the collector rings or brushes for inspection or replacement. A collector ring cover prevents snow from entering the collector ring area.

The stator frame and core assembly is of welded construction to provide a rigid structure for the traction, HEP, and companion alternator stator windings and support the end housing. The class "H" insulated traction alternator stator coils, Figure 2, are internally connected at the bearing end of the stator into two sets of three-phase "Y" connected windings that are paralleled at the rectifier banks.

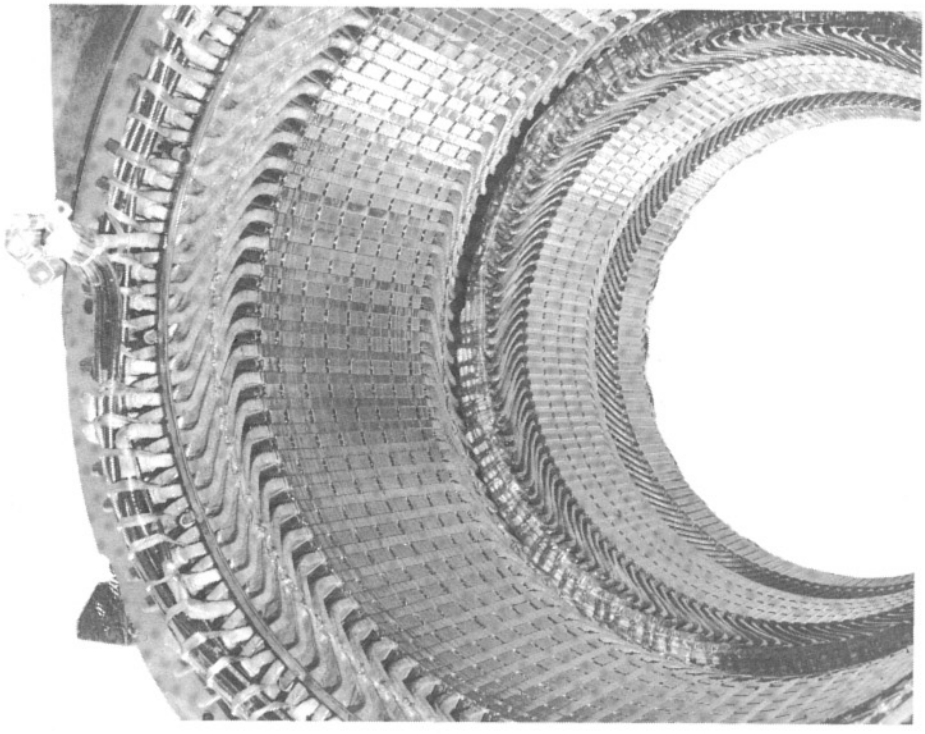

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Figure 2. Stator Frame Assembly.

Two rectifier assemblies mounted on the front of the main generator provide means of converting three-phase AC power to DC power. Refer to Figure 3 on page 3. The rectifier bank on the right hand side is for the traction alternator and the left side rectifier bank is for the HEP alternator. Each assembly consists of high-current, high-voltage, silicon diodes connected in a three-phase, full wave, rectifier circuit, and mounted on heat sinks capable of providing adequate cooling.

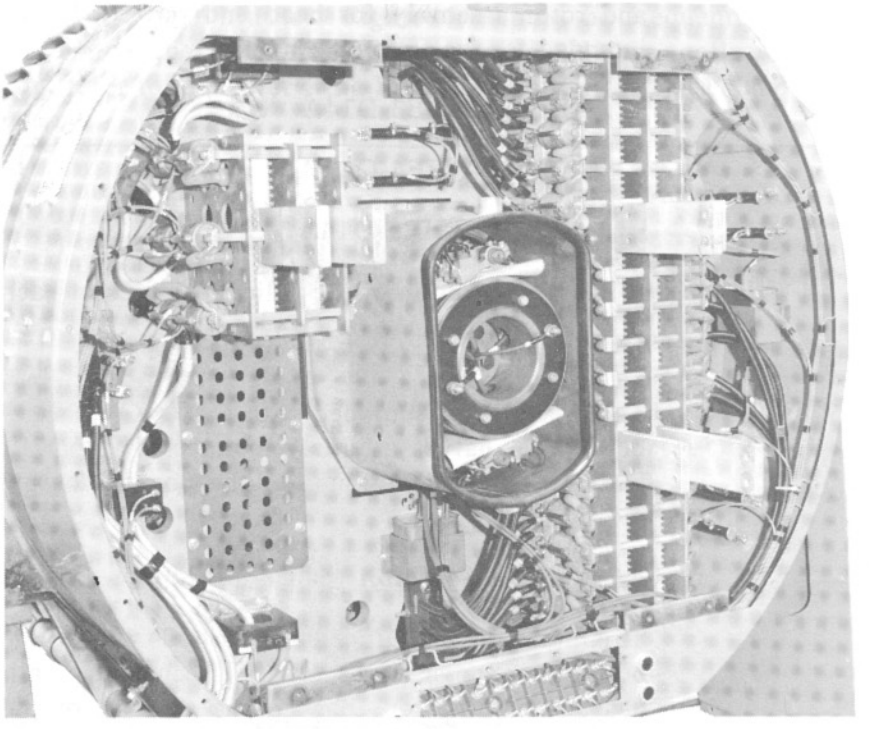

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Figure 3. Rectifier Banks

NOTE

Refer to M.I. 3306 for more information on the D14 alternator.

MODEL DESIGNATIONS AND DIFFERENCES

Several characteristics determine the particular model number given to a generator.

1. The output voltage and power rating of the traction and HEP alternator.
2. The minimum generator (engine) speed that will provide full output.
3. The type of suppression circuit employed, and the rating of suppression components.
4. The use or lack of current transformers.
5. The voltage class of the diodes employed.
6. Restriction as to diode type used (special order only).
7. Configuration of air box.
8. Type of coupling disc employed.
9. Application of wedges at the rotor coils.

There are several generator models that are equipped with a third stator and rotor assembly for head end power. This Maintenance Instruction is intended for the following models :

- AR10JBA-HE3-D14A
- AR10JBA-HE4-CA5A
- AR10JKA-HE5-D14A

A short description of the salient features of each model is provided.

AR10JBA-HE3-D14A (part # 40015512)

This machine is equipped with a 400 KW, 1000 VDC, HEP alternator with both stator halves internally connected in parallel at the rectifier bank and has one external bus bar for the positive output and one for the negative output.

AR10JBA-HE4-CA5A (part # 40024050)

This machine is equipped with a 400 KW, 1500 VDC, HEP alternator with both stator halves internally connected in parallel at the rectifier bank and has one external bus bar for the positive output and one for the negative output.

AR10JKA-HE5-D14A (part # 40022998)

This machine is equipped with a 300 KW, 3000 VDC, HEP alternator with both stator halves internally connected in series for higher output voltage and has one external bus bar for the positive output and one for the negative output. Two additional bus bars connect the banks in series externally. This model is a through-shaft machine that was designed for Roots blown diesel engines.

NOTE

Inspections and maintenance should be performed at the time intervals as specified in the Scheduled Maintenance Program.

CLEANING

Both the interior and exterior of the traction alternator should be kept clean and free of dust, dirt, oil, and water which are likely to have a detrimental effect on insulation and performance.

As often as conditions warrant, the alternator should be blown out with low pressure air. Avoid excessive air pressure which could cause damage to insulation.

Clean bound-edge, lintless wiping cloths should be used as necessary to remove oil, grease, and accumulations of dirt. It is essential that the rectifier sections be kept as clean as possible at all times.

COLLECTOR RINGS AND BRUSHES

Collector rings and brushes, Figure 4, should be frequently checked for sparking while the generator is in operation. If the collector rings are sparking, refer to Collector Ring Sparking section for causes and repair.

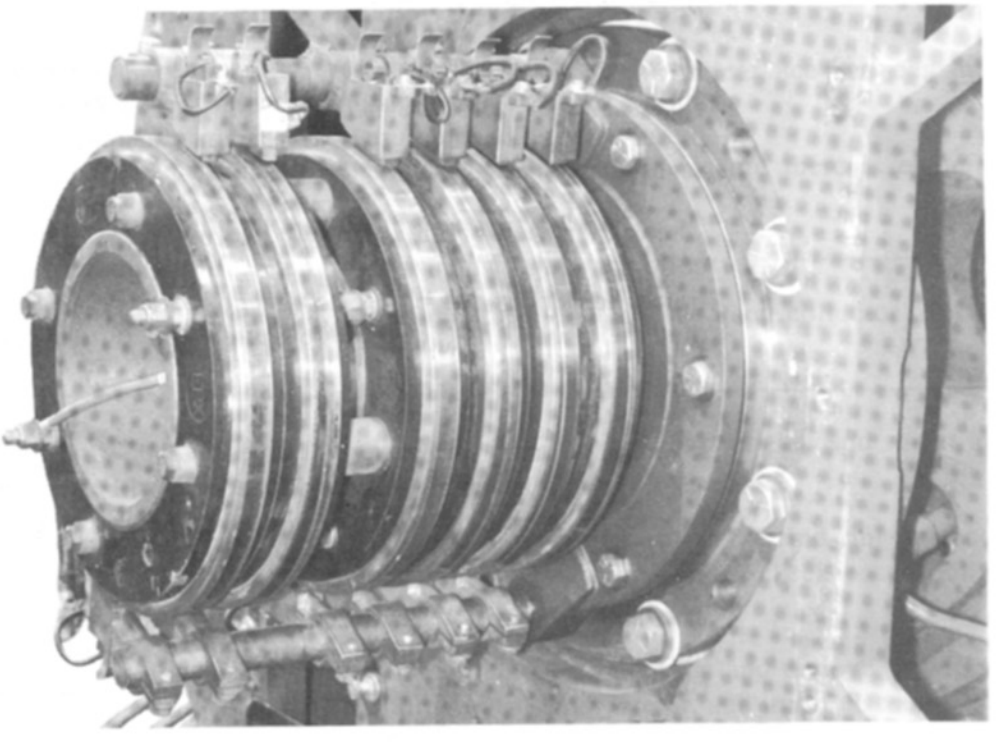

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Figure 4. Collector Ring And Brush Arrangement

NOTE

It is normal for the negative collector ring to wear more rapidly than the positive ring. The unequal wear can be minimized by reversing polarity of the rings every six months. Refer to Service Data for condemning limits of the collector rings and brushes.

COLLECTOR RING SPARKING

Sparking on collector rings should be corrected immediately to prevent failure of the generator.

The various causes of sparking and their remedies follow.

OIL ON SURFACE OF COLLECTOR RING

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

BRUSH HOLDER LOOSE

The generator is equipped with twelve constant pressure brush holders, six mounted at the top of the collector ring assembly, and six at the bottom. If a brush holder is not mounted securely to the brush holder stud or the stud itself is loose, it will allow the brushes to bounce on and off the collector ring, resulting in sparking. Tighten all mounting bolts.

DAMAGED BRUSH HOLDER

Make certain that brushes are free to move up and down in their slots. The spring pressure, on constant pressure brush holders, is preset and cannot be adjusted. The pressure will remain constant throughout the brush life, regardless of brush wear. Refer to Service Data for spring pressure value.

Check that each brush is centered to within 1/16 in (1.6 mm) of the mating collector ring, when facing the brush holders. The right-hand side of all brush holders is set closer to the collector rings than the left side. Check that the right-hand side is 1/16 in +/- 1/32 in (1.6 mm +/- 0.8 mm) closer.

ECCENTRIC OR PITTED COLLECTOR RINGS

If collector ring eccentricity exceeds 0.006 in (0.15 mm) total indicator reading (ring assembly installed) the ring will have to be machined to bring it into tolerance. A rough or pitted collector ring surface should also be cleaned up by machining.

The above conditions can usually be corrected by grinding. However, the minimum acceptable diameter of collector rings is 10-3/4 in (273 mm). If rings cannot be cleaned up without going below minimum diameter, they should be renewed. Rings should also be renewed if lateral runout exceeds 1/32 in (0.8 mm).

A collector ring grinder is available (8219264) which must be mounted to the generator with adapter 9506268.

COLLECTOR RING GRINDING

Use the following procedure to grind the collector ring surface.

CAUTION

Never use emery cloth to polish collector rings or to sand new brushes.

1. Remove the collector ring cover (snow guard), the six 12 o'clock brush holders, and remove diode fuses as required to provide clearance for the grinder and adapter. If brushes are to be reinstalled, label them so that they may be reinstalled in their original positions.

2. Mount adapter assembly at the 2 o'clock position on the bearing housing flange using two of the eight 3/4"-10 bearing housing bolts.

CAUTION

Use care to avoid damage or loss of the insulating washers or insulating strip, and bolt hole insulated tubes surrounding the bearing housing to end housing bolts so that electrical isolation of the bearing is maintained.

3. Mount collector ring grinder to grinder adapter.
4. Position grinder so that there is 1/8 in (3 mm) clearance between the grinder and the collector ring to be ground.
5. Install grinding stones in position on grinder. Ensure there is enough travel to grind the rings.

CAUTION

Make certain that grinding stones do not contact collector ring surface until generator begins rotating.

6. Make necessary preparations to start engine. Start engine and run it at approximately 600 RPM.
7. Gradually bring stones in contact with ring surface. Grind ring surface until it is smooth. After grinding, stop engine and recheck eccentricity with a dial indicator.
8. When grinding operation is complete, stop engine and remove grinding equipment. Blow all grinding dust from stator and rotor assemblies. Use high volume low pressure air.

NOTE

Generators are equipped with twelve constant pressure brush holders, six mounted at the top of the collector ring assembly, and six at the bottom. The brushes riding on the two inside collector rings are for the traction generator, the brushes on the two center collector rings are for the companion alternator, and the brushes riding on the two outside collector rings are for the HEP alternator. The spring pressure is preset and cannot be adjusted. The pressure will remain constant throughout the brush life, regardless of brush wear.

9. Reassemble brush holder assemblies in their proper positions. Renew brushes if necessary, refer to Brush Renewal.

BRUSH RENEWAL

When installing new brushes, they should be sanded to fit the curvature of the collector ring. This can be done by placing a piece of sandpaper on surface of ring with rough side against brush. Then with the brush held down by brush holder spring tension, move sandpaper in direction of normal rotation of rotor shaft until brush conforms to ring surface.

BEARING

A sealed, grease lubricated, self-aligning bearing is assembled into an insulated housing. The bearing housing is insulated to prevent damage from electrical arcing. No additional lubrication, other than recommendations in the Scheduled Maintenance Program, is required. Occasional checks of bearing temperature during operation will give an indication of bearing condition. Obtain temperature readings by applying a pyrometer to the outside surface of the bearing cover. Bearing temperature should not exceed a 104°F (40°C) rise. High bearing temperature may be caused by:

1. Contamination of grease.
2. Excessive thrust due to misalignment.
3. Pounding caused by worn rollers of bearing being loose on shaft.
4. Actual bearing failure caused by bearing fatigue or wear.

NOTE

The generator models detailed in this Maintenance Instruction have a 10.2362 inch (259.999 mm) bearing.

The bearing will require maintenance at intervals recommended in the Scheduled Maintenance Program.

BEARING MAINTENANCE

The 10.2362 inch (259.999 mm) bearing requires maintenance at intervals recommended in the Scheduled Maintenance Program. This can be accomplished either by removing the main generator from the installation and following the Generator Disassembly procedure of this instruction or by maintaining the bearing with the generator in place as follows:

1. Remove the air box center section and both side sections from which the bus bars protrude.
2. Remove collector ring cover.
3. Disconnect collector ring brush holder connections and tape leads away from work area.
4. Remove top and bottom brush holders from mounting studs.
5. Disconnect field leads from collector ring studs, Figure 5 on page 9.
6. Remove the four bolts securing the retainer plate, Figure 5 on page 9, to the end of the shaft and remove retainer plate.

NOTE

All puller tools used to remove the collector ring assembly and outer seal may be fabricated as detailed in File Drawings listed in Service Data.

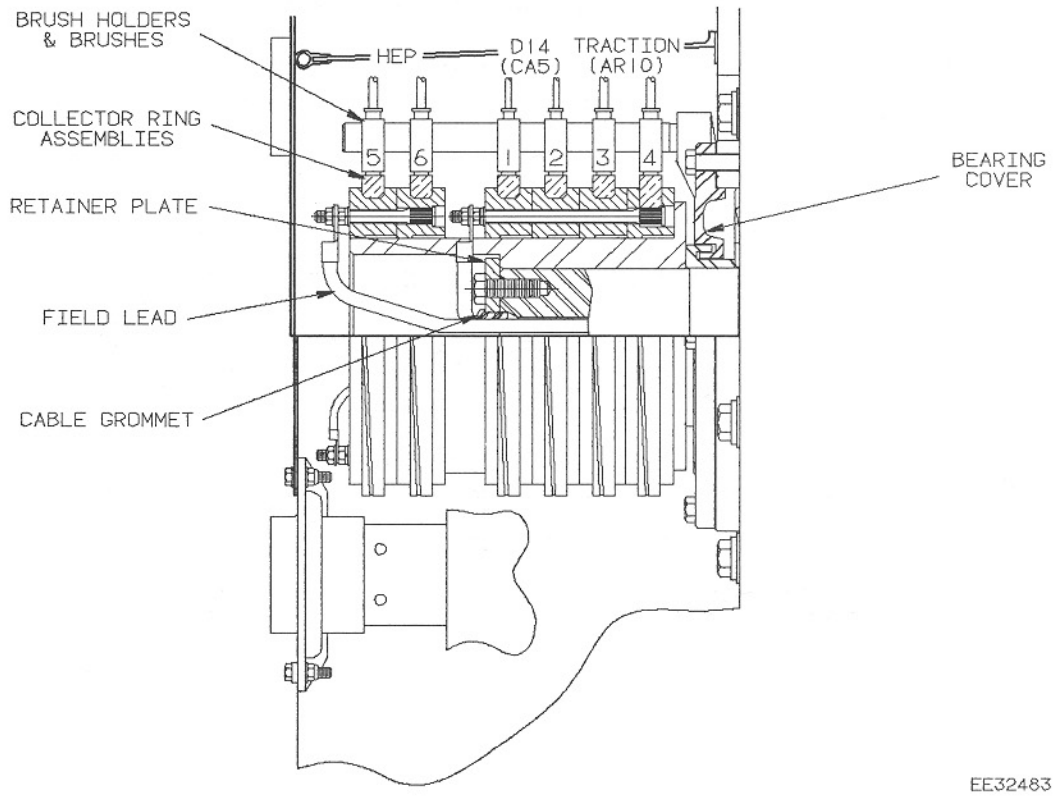


Figure 5. Collector Ring Assembly

7. Remove four 3/8″-16 bolts securing the collector rings to the collector ring hub. The bolts are located on the collector ring face between the lead connection terminals, Figure 4 on page 5. Place extension cup around field leads and bolt cup to shaft as shown in Figure 6 on page 10.

8. Install puller plate and puller studs to remove collector ring assembly, as shown in Figure 6 on page 10. Place jack assembly between the extension cup and the puller plate, supported by cradle studs of the puller plate. Connect hydraulic pump to jack assembly. Ensure puller is pulling equally on all studs to prevent damage to collector ring. Apply hydraulic pressure to jack assembly to remove collector ring assembly.

9. Remove puller studs from collector ring assembly.

10. Install puller plate and puller studs to remove outer seal, as shown in Figure 6 on page 10. Place jack assembly between extension cup and puller plate, supported by cradle studs of the puller plate. Connect hydraulic pump to jack assembly. Ensure puller is pulling equally on all studs to prevent damage to outer seal. Apply hydraulic pressure to jack assembly to remove outer seal. Remove jack assembly, hydraulic pump, puller plate, and puller studs.

11. Remove bolts from bearing cover, Figure 5, and remove cover. If cover is stuck to bearing housing, hit outer edge of cover with a rawhide mallet or similar tool to loosen.

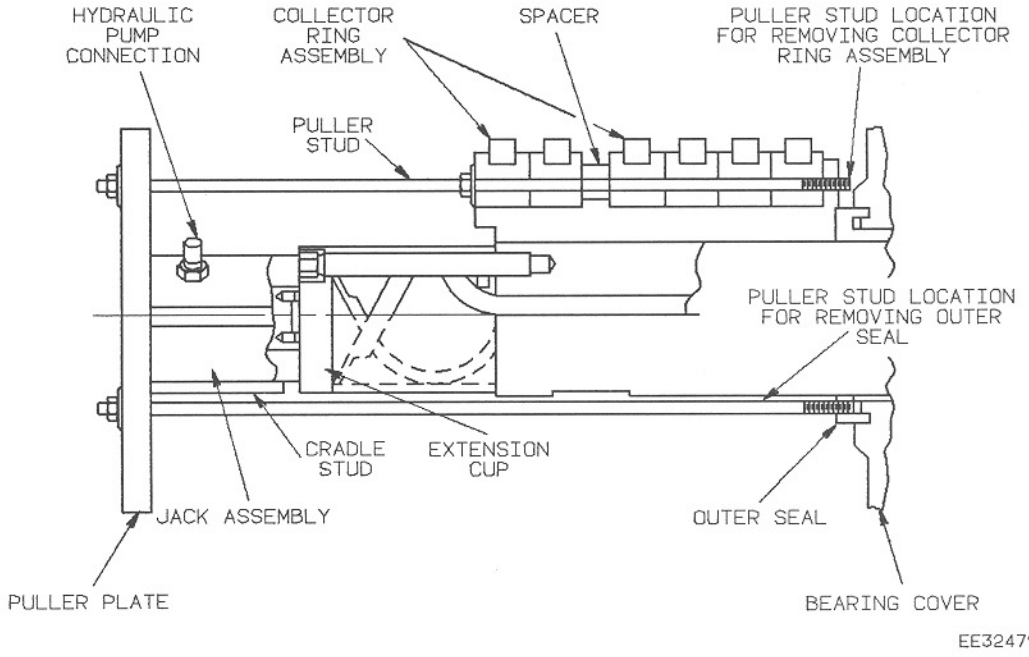


Figure 6. Collector Ring And Outer Bearing Seal Removal

12. Inspect grease in the bearing cover and inspect exposed side of the bearing. Look for metal particles in the grease, excessive wear in the housing of the bearing, fatigue damage on the rollers or roller path, or evidence of overheating. Replace bearing with a new bearing, if required, and replace any associated parts found in distress.

13. If no distress is found, thoroughly clean the bearing cover.

14. Fill the labyrinth grooves in the bearing cover with Esso Unirex N-2 grease. This grease need not be measured.

15. Weigh the piece of paper that will be used in handling the grease to fill the groove in bearing cover. The weight of the paper must be compensated for when weighing the grease.

16. Carefully weigh the Esso Unirex N-2 grease for the bearing cover groove. Refer to Service Data for proper quantity.

NOTE

Adequate lubrication depends upon precise weight of grease. Too much grease is as detrimental to the service life of the bearing as too little.

17. Pack grease into bearing cover groove. Leave a space free of grease at the top of the bearing cover to limit churning and liquefaction of the grease. Form grease to proper contour as shown in Figure 7 on page 11.

18. Remove old grease from exposed side of bearing and as much as possible from between the rollers and cage. Use only a putty knife and fingers. Do not use a solvent. Be careful not to introduce dirt or any other foreign substance into the bearing. Repack all spaces on the exposed side of the bearing with grease. If Shell Cyprina grease is present in the bearing, Esso Unirex N-2 grease may be added.

19. Install the greased bearing cover with new gasket. Ensure the space free of grease is at the top of the cover. Tighten bearing cover bolts 50 to 55 ft-lbs (68 to 75 N-m)

CAUTION

In Step 20, do not allow seal to be heated above 220°F (105°C). Overheating may result in warping or damaging the metal.

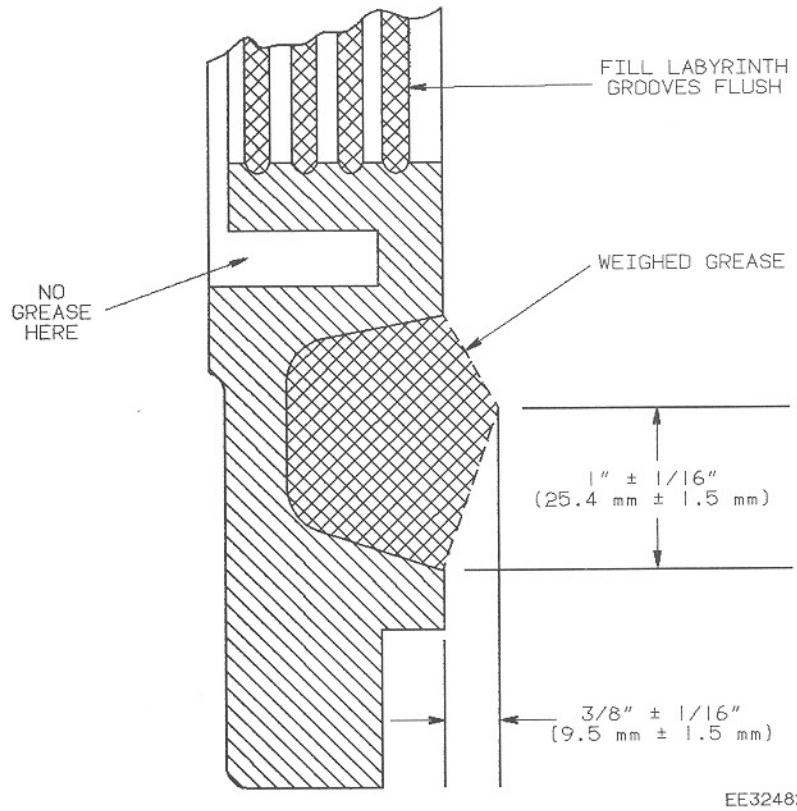


Figure 7. Application Of Grease To Bearing Cover

20. Heat the outer seal in an oil bath, electric oven, or induction heater for half an hour at 220°F (105°C). If an oil bath is used for heating,

remove oil from seal with clean, bound-edge cloths prior to shrinking to the shaft. When using an induction heater, pyrometer readings (with current off) should be taken periodically. After heating, shrink the seal to the shaft and allow it to cool to room temperature.

21. Place collector ring on induction heater and heat to 220°F (105°C). Pyrometer readings (with current off) should be taken periodically. After heating, place collector ring against outer seal. Rotate ring assembly on shaft for proper position of lead connections to terminals of ring assembly.

WARNING

If work involving collector ring connections has been performed, use a continuity tester (with all field leads disconnected and all brushes lifted) to check that collector ring terminals marked 1 through 6 on the steel housing adjacent to the terminals are connected to the appropriate collector rings (No. 5 outboard, No. 4 inboard).

22. Place retainer plate over leads and on to the end of the rotor shaft. Tighten 5/8″-11 bolts to 100 to 110 ft-lbs (135.5 to 149 N-m).

23. Connect the large leads from the traction alternator to collector ring terminals 3 and 4, the large size leads from the HEP alternator to collector ring terminals 5 and 6, and the small size leads from the companion alternator to terminals 1 and 2. Torque to 7 to 9 ft-lbs (9.5 to 12.2 N-m).

24. Install brush holders. Large brush holders for traction alternator over collector ring positions 3 and 4 and, large brush holders for HEP alternator over collector ring positions 5 and 6, and small brush holders for companion alternator over collector rings 1 and 2.

25. Attach jumper leads J1, J2, J3, J4, J5, and J6 between top and bottom brush holders having the same numbers. The jumper leads attach to brush holder locking screws which secure holder to insulated studs.

26. Route leads to the left of the collector ring assembly. Secure leads with the cable clamps bolted to the threaded holes in the bearing housing. Connect external leads 1, 2, 3, 4, 5, and 6 to corresponding lower brush holder terminals.

27. Adjust brush holders to have 1/8 inch (3 mm) clearance over collector rings. In addition, ensure that brush holder is centered over the collector ring. Torque brush holder locking screws to 10 to 15 ft-lbs (14 to 20 N-m). Assemble brushes in holders. If used brushes are reinstalled, ensure that the original positions are maintained. Check that each brush is centered within 1/16 inch (1.6 mm) of the mating collector ring.

28. Install collector ring cover and sections of air box covers removed during disassembly.

BEARING CHANGEOUT

Traction alternators require bearing replacement when inspection has determined that the bearing is defective or at intervals recommended in the Scheduled Maintenance Program.

The traction alternator bearing can be changed out either by removing the alternator from the installation and following the Generator Disassembly procedure of this instruction or by changing out the bearing with the generator in place as follows:

BEARING REMOVAL (Generator In Place)

1. Perform Steps 1 through 8 of Bearing Maintenance procedure and then install support tube as shown in Figure 8. Support shaft through a "V" block with an adjustable jack.

2. Remove eight 3/4"-10 bolts securing bearing housing to the end housing, Figure 8. Insert four 3/4"-10 jacking bolts equally spaced around the bearing housing in jacking holes provided. Rotate jacking bolts equally until bearing housing is separated from the end housing.

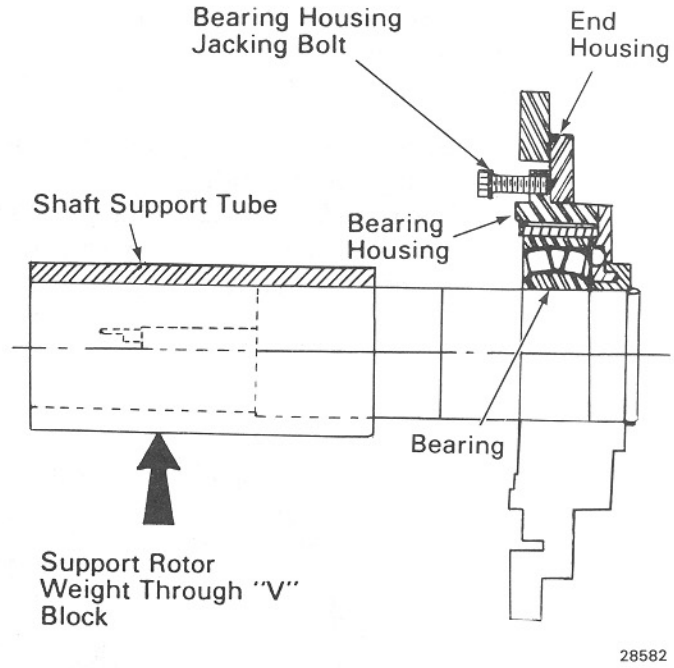


Figure 8. Bearing Housing Removal

3. Lower the adjustable supporting jack until rotor rests on stator. Remove the jack and shaft supporting tube. Slide bearing housing off the shaft. Remove any burrs from end housing which may have been caused by jacking bolts.

4. Install rotor shaft jacking fixture as shown in Figure 9 on page 14.

5. Raise rotor until bearing is approximately centered in the bore of the housing.

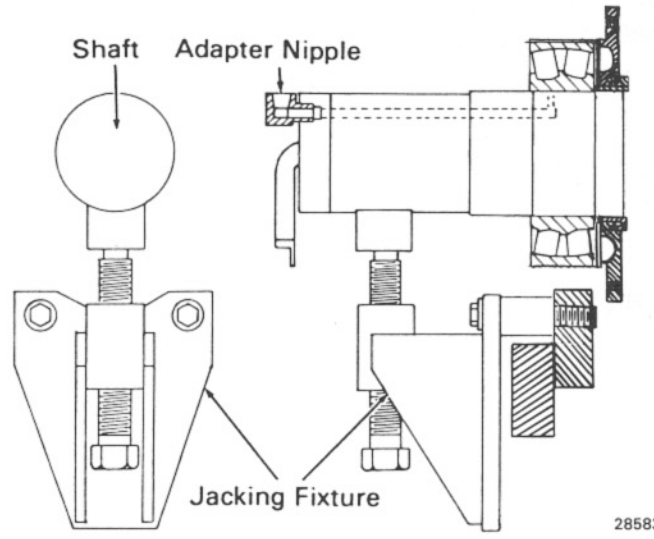


Figure 9. Rotor Shaft Jacking Fixture

6. The rotor shaft has a tapped hole in the end of the shaft for hydraulic bearing removal. Perform the following procedure. Two hydraulic pumps are required to perform the following procedure.

   A. Ensure threads and pressure fitting seat are cleaned in the drilled passage in the shaft.
   B. Screw a 1/8″-27 adapter nipple, Figure 9, into tapped hole in shaft and tighten. Refer to Service Data for adapter nipple part number.
   C. Connect hydraulic pump, Figure 10, to adapter nipple.

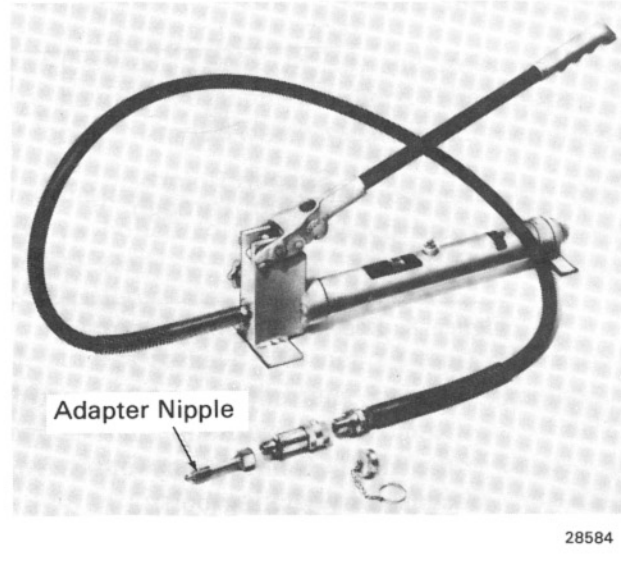


Figure 10. Hydraulic Pump

7. Thread six puller studs into flange of bearing cap. Install six spacer tubes and centering ring as shown in Figure 11 on page 15.

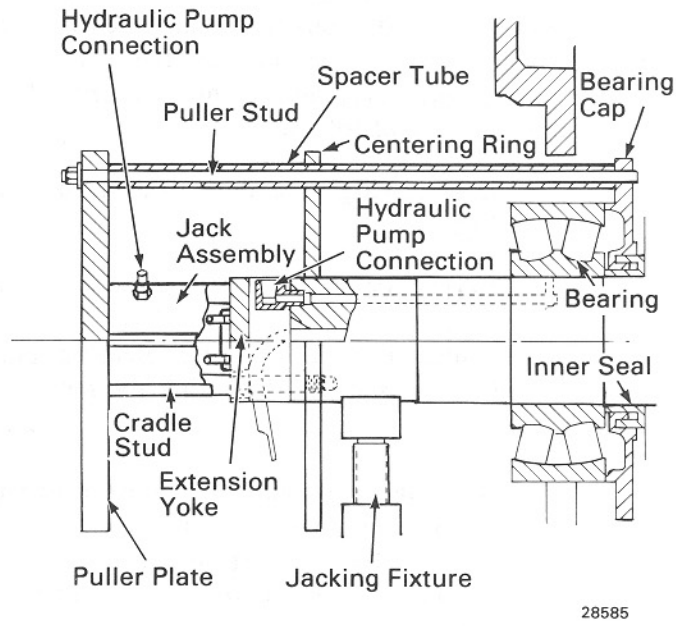


Figure 11. Bearing Removal

8. Place extension yoke around field leads and bolt extension yoke to shaft as shown in Figure 11.

9. Install puller plate. Place assembly jack between extension yoke and puller plate, supported by cradle studs of puller plate as shown in Fig. 11.

10. Apply hydraulic pressure to expand inner bearing race. Maintain this pressure while applying hydraulic pressure to the jack assembly until the bearing slides off the shaft seat - approximately 2-1/2 inch (63.5 mm). Ensure that puller is pulling equally on all studs to prevent damage to bearing.

11. Lower the rotor with the jacking fixture until it contacts the stator. Remove jacking fixture and pulling equipment. Slide bearing and bearing cap off the rotor shaft.

12. Examine bearing inner seal for evidence of rubbing. If rubbing appears excessive, remove bearing inner seal, using a small heating torch and pry bars.

BEARING INSTALLATION (Generator In Place)

When all associated bearing parts have been cleaned and inspected, the bearing is ready for assembly.

Before shrinking bearing to rotor shaft, it is very important to try the bearing in the housing. Place bearing housing on the floor and slide bearing through the bore of the housing. Ensure bearing enters bearing housing squarely, and is not cocked. Refer to Service Data for bearing dimensions and tolerances.

Use the following procedure to assemble bearing. Refer to Fig. 12 during assembly.

CAUTION

Care should be used when heating bearing parts. Overheating may result in warping or damaging the metal.

1. If bearing inner seal was removed because of rubbing, heat a new inner seal in an oil bath, electric oven, or induction heater for half an hour at 220°F (105 °C). If an oil bath is used for heating, remove oil from seal with clean, bound-edge cloths prior to shrinking to the shaft. When using an induction heater, pyrometer readings (with current off) should be taken periodically. After heating, shrink the seal to the shaft and allow to cool to room temperature.

2. Fill labyrinth grooves in the bearing cap with Esso Unirex N-2 grease. This grease need not be measured. The bearing cap can be distinguished from the bearing cover by noting that the bearing cap has tapped holes in the flange while the bearing cover has holes which are not tapped.

3. Weigh the piece of paper that will be used in handling the grease. The weight of the paper must be compensated for when weighing the grease.

NOTE

Esso Unirex N-2 grease must be used exclusively to lubricate a new or cleaned bearing. Adequate lubrication depends upon precise weight of grease. Too much grease is as detrimental to service life of the bearing as too little. Bearing replacement kits include pre-weighed amounts of grease.

4. Carefully weigh the Esso Unirex N-2 grease for the bearing cap groove. Refer to Service Data for proper quantity.

5. Pack the grease into bearing cap groove. Leave a space at the top of the bearing, as shown in Figure 7 on page 11 to limit churning and liquefaction of the grease. Form grease to proper contour as shown in Figure 7 on page 11.

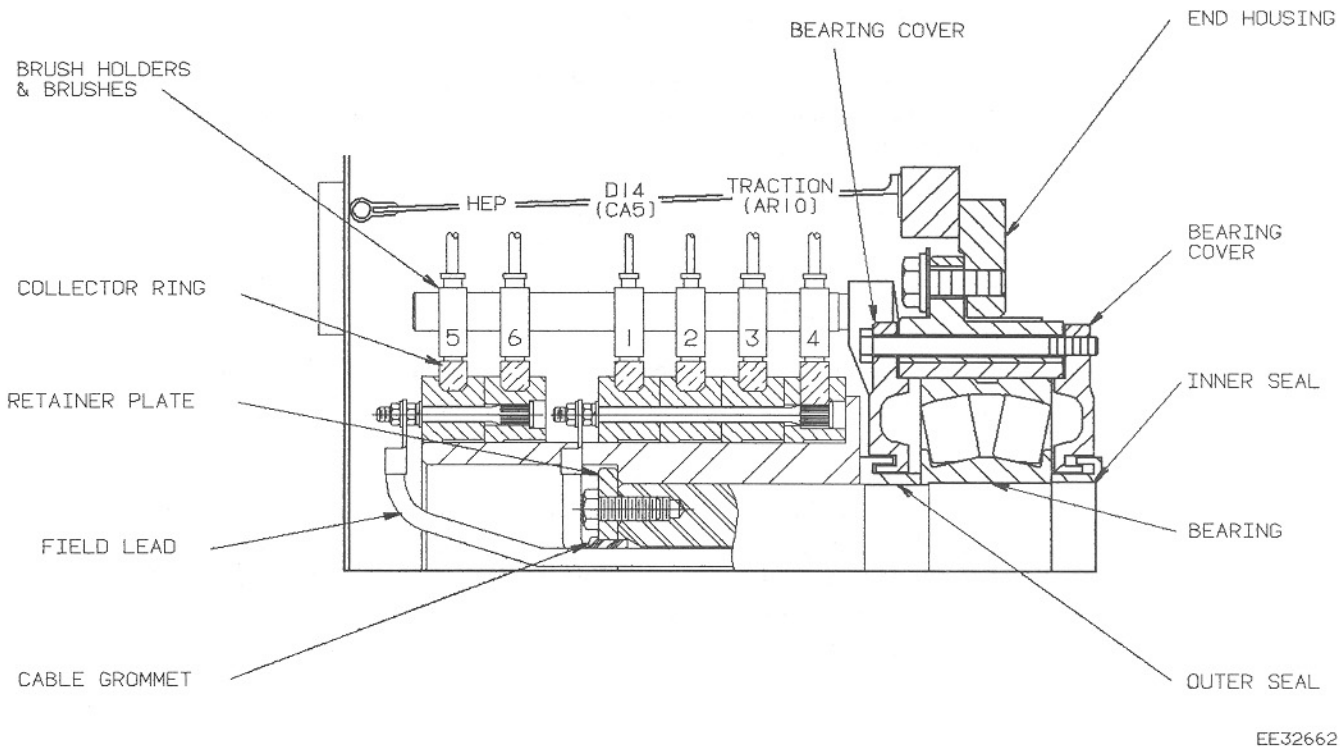


Figure 12. Bearing And Collector Ring Assembly Cross-section

6. Install greased bearing cap and a new gasket onto shaft.

7. Carefully weigh the Esso Unirex N-2 grease for the new bearing. Refer to Service Data for the proper quantity. Pack the bearing rollers and the space in between the two rows of rollers with grease.

8. Heat roller bearing with an induction heater to 220°F (105°C). Take pyrometer readings (with current off) at outside face of inner race only. Shrink bearing to shaft with the part number toward the outside. Do not cock the bearing when placing it on the shaft. Use a brass pipe to push bearing on shaft and seat firmly against inner seal. Let bearing cool to room temperature.

9. Thread two 1/2″-13 studs, 180° apart, into bearing cap flange to correctly position cap during installation of the bearing housing. Ensure gasket is in place. Slide bearing housing into shaft.

10. Apply Molykote paste 9517921 to inside diameter of bearing housing.

11. Install two 3/4″-10 aligning studs 180° apart into two of the eight bearing housing mounting bolt holes in the end housing. The aligning studs will help prevent the bearing from cocking (damaging insulation material), when assembling bearing housing to end housing.

12. Position new insulating ring Figure 13 on page 18 over aligning studs so that holes in the ring line up with holes in the end housing.

13. Slide bearing housing over shaft.

14. Install shaft support tube and supporting jack as shown in Figure 8 on page 13. Raise rotor until bearing is centered in the bore of the bearing housing.

15. Position bearing housing so that bearing housing and bearing cover bolt hole pattern relationship is as shown in Figure 14 on page 19. This relationship is important to position brush holder studs at top and bottom positions.

16. Align bearing cap to bearing housing and bearing housing to end housing using the aligning studs. Move bearing housing part way onto bearing. Install special 3/ 4″-10 x 5″ pulling studs through the bearing housing mounting holes and into the end housing. DO NOT ALLOW THE BEARING OUTER RACE TO BECOME TILTED IN THE BEARING HOUSING. Keep the bearing housing parallel to the end housing by tightening the pulling bolts only a partial turn in 180° pairs before proceeding to the next pair. Continue to tighten bolts evenly until the bearing housing is seated. Remove aligning studs and pulling studs.

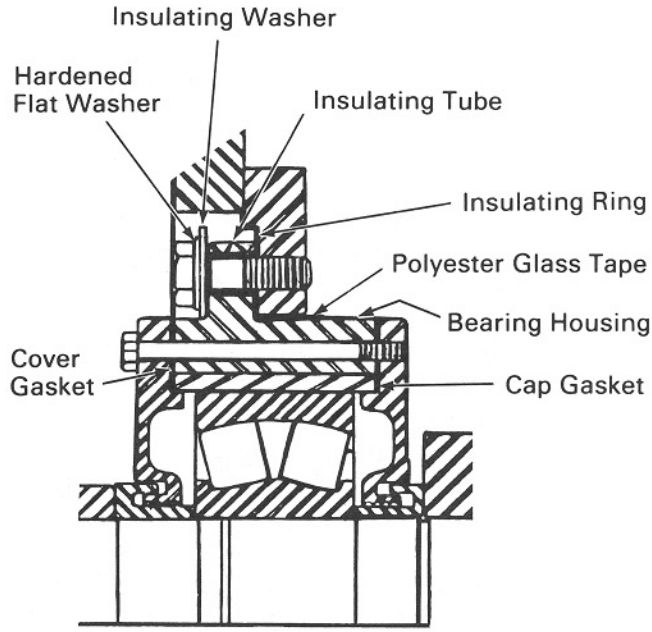


Figure 13. Bearing Insulation

17. Install eight insulating tubes into bearing housing mounting bolt holes.

18. Apply one insulating washer under each hardened flat washer 9531331 and install bolts to bearing housing. Torque bearing housing bolts to 150 ft-lbs (203 N-m).

19. Check insulation resistance between bearing housing and end housing using a 1000 volt megohmmeter. Reading must be a minimum 1 megohm. If reading is not satisfactory, remove bearing housing and inspect insulating material for damage and renew if necessary.

20. Carefully weigh the Esso Unirex N-2 grease for the bearing cover groove. Refer to Service Data for proper quantity.

21. Pack the grease into bearing cover groove. Leave a space at the top of the bearing cover to limit churning and liquefaction of the grease. Form grease to proper contour as shown in Fig. 7.

22. Perform Step 18 through 28 of Bearing Maintenance procedure.

NOTE

Changing the generator bearing in this manner does not affect engine/ generator alignment, however, it is recommended that the alignment is checked before returning the unit to service.

If the stator has been moved or disturbed, realign generator per M.I. 1753.

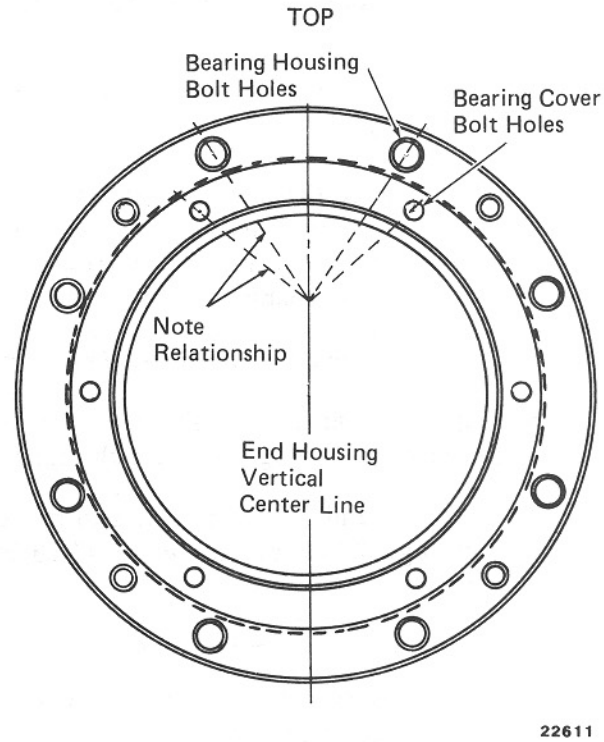


Figure 14. Installing Bearing Housing

GENERATOR DISASSEMBLY

NOTE

If equipment for disassembly and assembly is not available, generator should be returned to the Electro-Motive Division for repair either on a rebuild and return, or unit exchange basis.

Before the generator is removed from its location, place strips of fish paper approximately 1/16″ x 3″ x 36″ (2 mm x 80 mm x 900 mm) in the bottom air gap between the rotor assembly and stator coils. When removing the generator, be sure to tag shims used under mounting pads so they may be replaced in their original position.

The following steps apply in disassembling the generator. Refer to Figure 15 on page 21 during disassembly.

1. Mount generator on a sturdy stand at a suitable working height. Remove dust, dirt, oil, and grease from outside of generator. This will prevent dirt from entering during disassembly.
2. Remove all covers from the generator assembly.
3. Disconnect leads to brush holder and filter assemblies.
4. Remove bolts holding air box to end housing, and carefully remove air box.
5. Remove collector ring cover, brush holders and brush holder bracket assembly.
6. Disconnect the phase lead connections and suppression circuit connections at the bus bars of each rectifier bank assembly. Remove the cable cleats securing suppression circuit leads to the slides and ends of each rectifier bank assembly. Remove rectifier banks.
7. Remove cleat assemblies securing stator leads to end housing.
8. Apply an arbor fixture to spider bore of companion alternator rotor Figure 16 on page 22. Attach crane cable to end of fixture.
9. Support end housing with another crane cable and chains, Figure 17 on page 22. Remove eight 3/4″-10 bolts securing end housing to stator frame.

NOTE

End housing holding fixture may be fabricated as detailed in File Drawing referenced in Service Data.

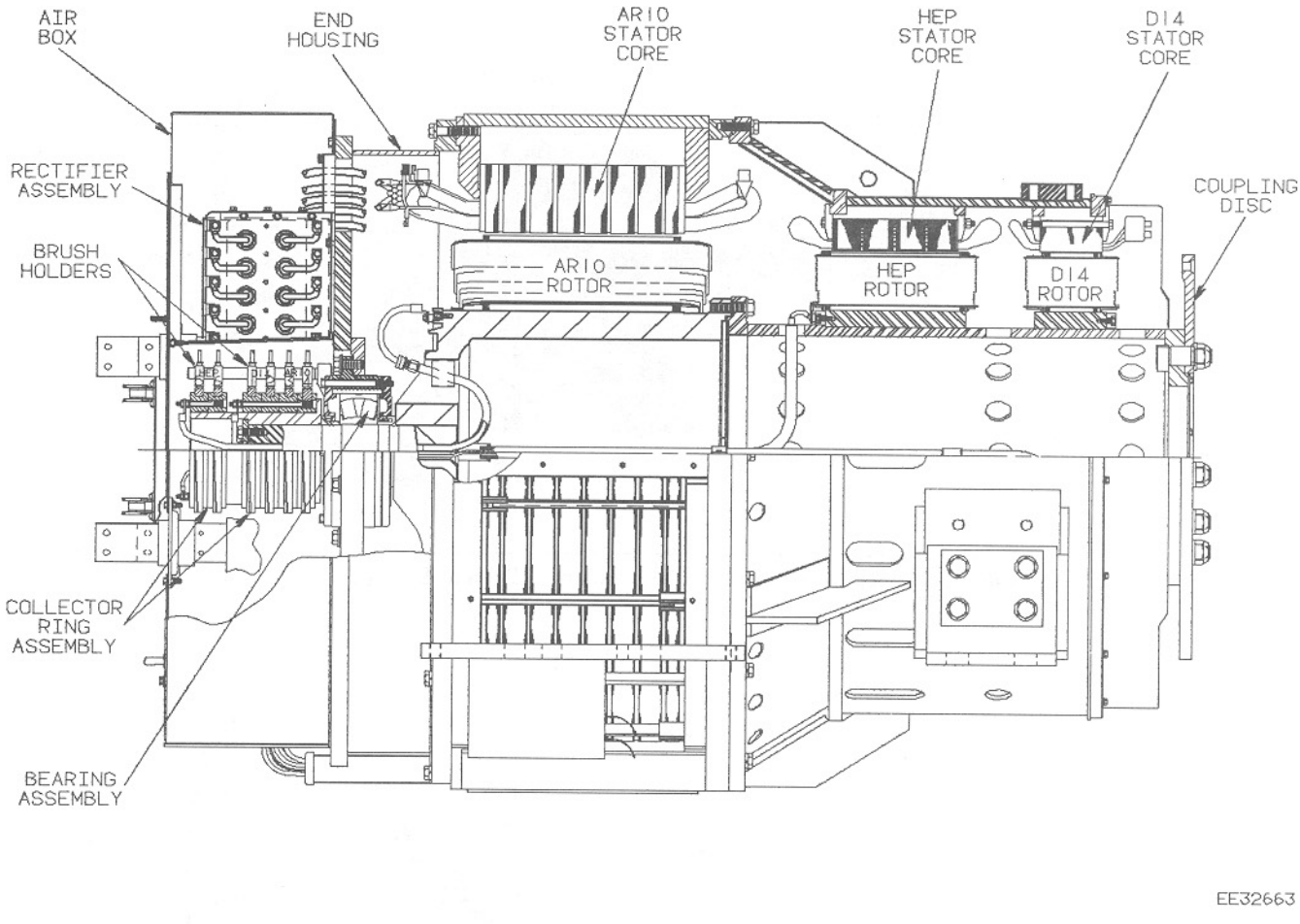


Figure 15. AR10-HEP-D14 Cross Section

10. Insert three 3/4″-10 jacking bolts equally spaced around end housing in bolt holes from which end housing mounting bolts were removed. Turn jacking bolts equally until end housing is separated from stator frame.

11. Raise arbor fixture until air gap is equal around circumference of rotor. Raise cable at end housing until taut.

> **CAUTION**
>
> Use extreme care to ensure that laminations and windings are not damaged when removing rotor.

12. Carefully remove rotor and end housing assembly from stator, moving it towards bearing end of assembly until it clears stator, Figure 18 on page 23.

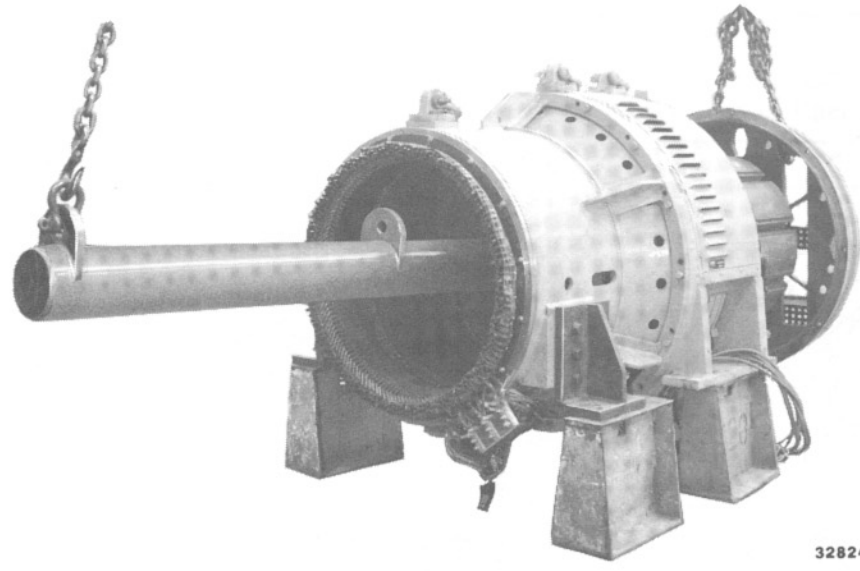


Figure 16. Application Of Arbor Fixture - Typical Setup

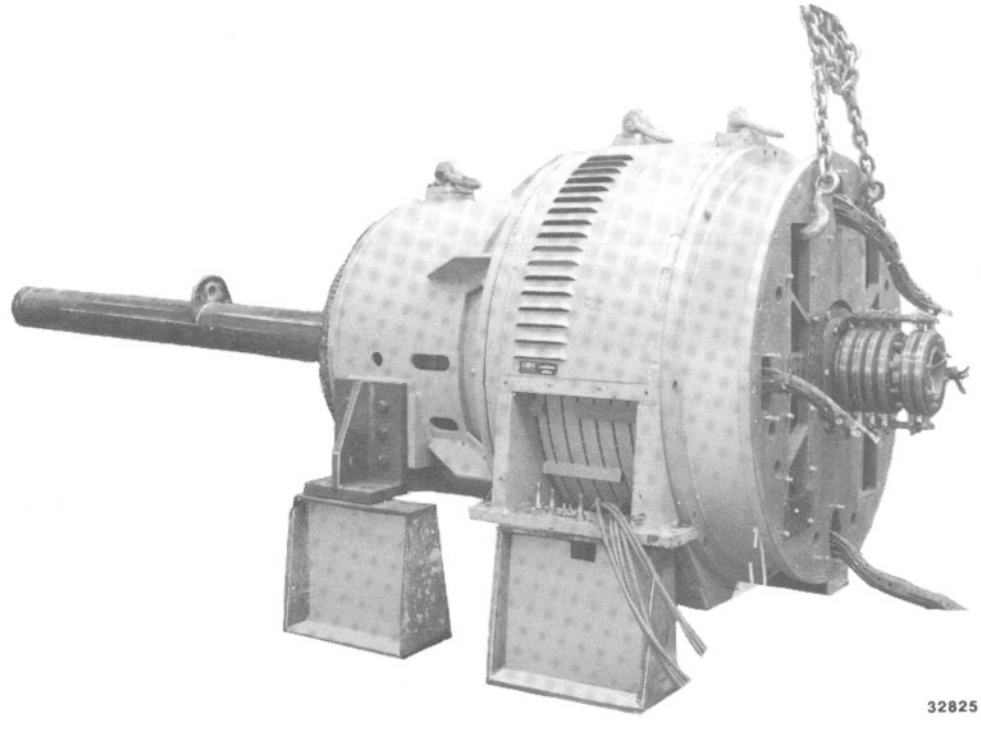


Figure 17. Attaching Crane Cable To End Housing

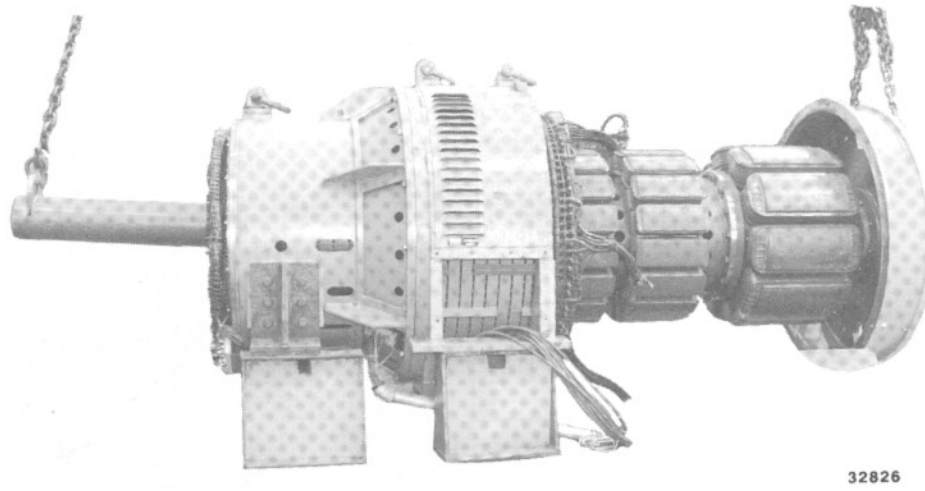


Figure 18. Removing Rotor And End Housing From Stator-Typical Setup

NOTE

If necessary, the coupling disc, companion alternator, and HEP alternator rotor can be removed from the traction alternator rotor.

13. Place rotor assembly on a cradle stand, Figure 19 on page 24 with strips of fish paper between rotor and cradle.

14. Disconnect field leads from collector ring studs. Refer to Figure 4 on page 5.

15. Remove the four bolts securing the retainer plate to the end of the shaft, and remove the retainer plate.

16. Remove four 3/8″-16 bolts securing the collector rings to the collector ring hub. The bolts are located on the collector ring face between the lead connection terminals Figure 4 on page 5. Place extension cup around field leads and bolt cup to shaft as shown in Figure 6 on page 10.

NOTE

All puller tools used to remove collector ring bearing outer seal, bearing, and bearing inner seal may be fabricated as detailed in File Drawings and Work Sketch Drawing listed in Service Data.

17. Install puller plate and puller studs to remove collector ring assembly, as shown in Figure 6 on page 10. Place jack assembly between the extension cup and the puller plate, supported by cradle studs of the puller plate. Connect hydraulic pump to jack assembly to remove collector ring assembly. Ensure puller is pulling equally on all studs to

prevent damage to collector ring. Apply hydraulic pressure to jack assembly to remove collector ring.

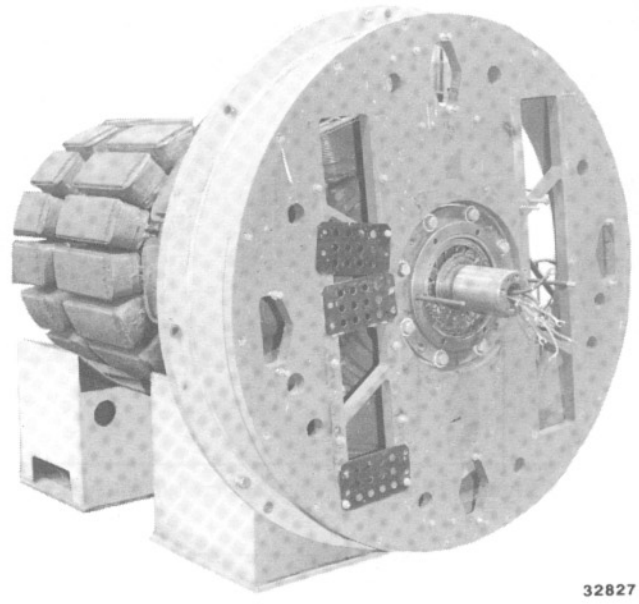


Figure 19. Rotor Assembly Removed From Stator

18. Remove puller studs from collector ring assembly and install original bolts.

19. Install puller plate and puller studs to remove outer seal as shown in Figure 6 on page 10. Place jack assembly between extension cup and puller plate supported by cradle studs of the puller plate. Connect hydraulic pump to jack assembly. Ensure puller is pulling equally on all studs to prevent damage to outer seal. Apply hydraulic pressure to jack assembly to remove outer seal. Remove jack assembly, hydraulic pump, puller plate, and puller studs.

20. Remove bolts from bearing cover, Figure 5 on page 9, and remove bearing cover. If cover is stuck to bearing housing, hit outer edge of cover with a rawhide mallet or similar tool to remove cover and gasket.

> **NOTE**
>
> Use extreme care to ensure that bearing housing bore is not damaged when removing the bearing housing from the end housing.

21. Remove eight 3/4-10″ bolts securing bearing housing to end housing, Figure 20 on page 25. Insert four 3/4″-10 jacking bolts equally spaced around the bearing housing in special holes provided. Turn jacking bolts equally until bearing housing is separated from the end housing.

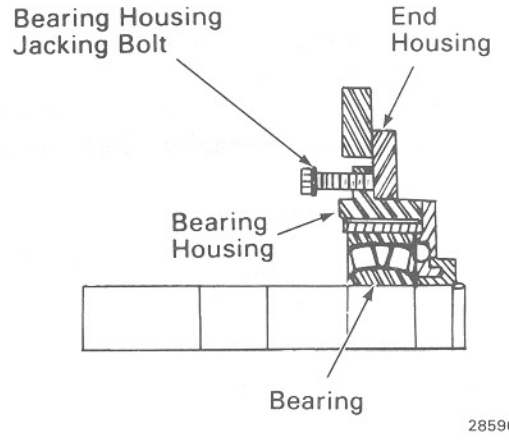


Figure 20. Bearing Housing Removal

CAUTION

Do not wash bearing housing in caustic solution or cob blast the housing bore. The bearing housing and housing bore dimensions are extremely critical and may be damaged.

22. The rotor shaft has a tapped hole in the end of the shaft for hydraulic bearing removal. Two hydraulic pumps are required to perform the following procedure.

    A. Ensure threads and pressure fitting seat are cleaned in the drilled passage in the shaft.

    B. Screw a 1/8″-27 adapter nipple, Figure 9 on page 14, into tapped hole in shaft and tighten. Refer to Service Data for adapter nipple part number.

    C. Connect hydraulic pump, Figure 10 on page 14, to adapter nipple.

23. Thread six puller studs into flange of bearing cap. Install six spacer tubes and centering ring as shown in Figure 11 on page 15.

24. Place extension yoke around field leads and bolt extension yoke to shaft as shown in Figure 11 on page 15.

25. Install puller plate. Place hydraulic jack between extension yoke and puller plate, supported by cradle studs of puller plate as shown in Figure 11 on page 15.

26. Apply hydraulic pressure to expand inner bearing race. Maintain this pressure while applying hydraulic pressure to thejack assembly until bearing slides off the shaft seat (approximately 2-1/2″ (63.5 mm). Ensure puller is pulling equally on all studs to prevent damage to bearing.

27. Remove bearing inner seal using small heating torch and pry bars.

28. Remove companion alternator stator closure assembly, if necessary.

29. Ensure the companion alternator stator assembly is properly supported and remove bolts securing the companion alternator stator assembly to the traction alternator stator assembly. Install 3/4-10″ jack bolts and remove the companion alternator stator assembly.

NOTE

Before the generator is assembled, it is advisable to electrically qualify the stator and rotor. Refer to Generator Testing at the back of this document.

BEARING

CLEANING

Before attempting to make any inspection, a bearing must be thoroughly cleaned. Stoddards solvent or similar noncorrosive solvent having a flash point of 115°F (46°C) or higher may be used.

A clean brush or lintless cloth can be used to facilitate cleaning. Gasket surfaces should be given special attention to remove all traces of remaining gasket material.

NOTE

If bearing components are not to be used immediately after inspection they should be coated with Esso Unirex N-2 grease to prevent corrosion while in storage.

INSPECTION

On all bearings with appreciable service, some dents, nicks, pits, and craters will be found. If these are small and scattered, they should not be cause for rejection; however, they should be evaluated with good judgement and with reference to the overall condition of the bearing. All doubtful parts should be discarded. Failed parts should be replaced with either new or acceptable reconditioned parts. If one part of an assembly has been subjected to excessive stress which results in a visible defect severe enough to reject the part, the rest of the assembly requires a detailed inspection and evaluation before reuse.

The roller bearing should be thoroughly inspected for possible evidence of impending failure. The following inspections are to be used when qualifying bearing components for re-use.

All exposed operating surfaces must be inspected visually to ensure that they contain none of the following defects which will be cause for rejection:

1. Wear - A properly lubricated bearing not subjected to misalignment, dirt, or distortion will show no evidence of wear. The internal radial

clearance of the bearing may be checked by passing a feeler gauge between the rollers and race of the unloaded side of the bearing. Do not roll a feeler through a bearing. For limits, see Service Data.

2. Fatigue Failure - Signs of fatigue failure will most usually appear on the bearing surface. Fatigue failure is usually evidenced as ragged craters, and may be of any size. Any bearing showing any sign of cracks or craters of any size, regardless of how small they may be, should be replaced. This type of failure is more likely to occur on either the rollers or inner race.

3. Protrusions above the normal surface.

> **NOTE**
>
> Protrusions should be reduced to the normal surface by light circumferential honing with Arkansas stone (novaculite) or grade 240 abrasive cloth. Likewise, the sharp edges should be smoothed. Care must be taken to work down to the normal surface only, to prevent reduction of contact area, and to work circumferentially so as to prevent the formation of flats.

4. Cracks and flats.

5. Ruptures, tears or seams 3/32 inch (2.4 mm) or more in length, or more than hairline width.

6. Scores, or deep scratches which extend more than 3/4 the length of the operating surface and are inclined at less than 10° to the axis.

7. Corrosion pits 1/32 inch (0.8 mm) or more in diameter.

8. Craters or pits from electrical arcing 1/32 inch (0.8 mm) or more in diameter.

9. Profuse denting.

10. Overheating.

11. Circumferential pattern of pits or dents at the ends of the roller path.

12. Fatigue pits, flaking, shelling or galling.

GENERATOR ASSEMBLY

> **NOTE**
>
> The main generator consists of an AR-type traction alternator, a head end power alternator, and a companion alternator.

After the generator stator and rotor have been cleaned and checked, the inside of the stator and the outside of the rotor should be painted with red air drying enamel.

When all the component parts have been cleaned, checked, inspected, and painted, the generator is ready for assembly.

Before shrinking bearing to rotor shaft, it is very important that the bearing be tried in its housing. Place bearing housing on floor and slide bearing through bore of housing. Ensure bearing enters the housing bore squarely, and is not cocked. See Service Data for bearing dimensions and tolerances.

Refer to Figure 15 on page 21 during assembly.

BEARING AND END HOUSING ASSEMBLY

1. Fill labyrinth grooves in the bearing cap and cover with Esso Unirex N-2 grease. This grease need not be measured.

2. Weigh the piece of paper that will be used in handling the grease. The weight of the paper must be compensated for when weighing the grease.

> **NOTE**
>
> Esso Unirex N-2 grease must be exclusively to lubricate a new or cleaned bearing. Adequate lubrication depends upon precise weight of grease. Too much grease is as detrimental to service life of the bearing as too little. Bearing replacement kits include preweighed amounts of grease.

3. Carefully weigh the Esso Unirex N-2 grease for the bearing cap and cover groove. Refer to Service Data for proper quantity.

4. Pack the grease into bearing cap and cover groove. Leave a space at the top of the bearing, as shown in Figure 7 on page 11, to limit churning and liquefaction of the grease. Form grease to proper contour as shown in Figure 7 on page 11.

5. Clean armature shaft and remove burrs or gall marks.

> **CAUTION**
>
> Care should be used when heating bearing parts. Overheating may result in warping or damaging the metal.

6. Heat the inner seal in an oil bath, electric oven or induction heater for half an hour at 220°F (104°C). If an oil bath is used for heating, remove the oil from the seal with clean, bound-edge cloths prior to shrinking to the shaft. When using an induction heater, pyrometer readings (when current off) should be taken periodically. After heating, shrink the seal to the shaft and let it cool to room temperature.

7. Install greased bearing cap with gasket onto shaft.

8. Pack the bearing rollers and the space between the two rows of rollers with the quantity and type of grease specified in Service Data. Fill groove in outer race with additional grease.

> **NOTE**
>
> If Shell Cyprina grease is present in the bearing, Esso Unirex N-2 may be added.

9. Heat roller bearing with an induction heater to 220 °F (105°C). Take pyrometer readings (with current off) at outside face of inner race only. Also see Caution before Step 6. Shrink bearing to shaft with the bearing part number toward the outside. Do not cock the bearing when placing it on shaft. Use a brass pipe to push bearing on shaft up to and against inner seal. Let bearing cool to room temperature.

10. Place end housing in a horizontal position with mounting flange down, and install two 3/4″-10 aligning studs 180° apart into two of the eight tapped bearing housing bolt holes in the end housing. The aligning studs will help prevent the bearing from cocking (damaging insulation material) when assembling bearing housing to end housing.

11. Position new insulating ring, Figure 13 on page 18, over aligning studs so that holes in the ring line up with the holes in the end housing.

12. Apply Molykote paste to inside diameter of bearing housing prior to assembling bearing housing to bearing.

13. Position bearing housing so that bearing housing and bearing cover bolt hole pattern relationship is as shown in Figure 14 on page 19. This relationship is important to position brush holder studs at top and bottom position.

14. Carefully lower bearing housing into position guided by aligning studs. Gently tap bearing housing until bearing housing bottoms out on the end housing. Remove aligning studs.

15. Install eight insulating tubes into bearing housing mounting bolt holes.

16. Apply one insulating washer under each hardened flat washer 9531331 and install bolts to bearing housing. Torque bearing housing bolts to 150 ft-lbs (203 N-m).

17. Check insulation resistance between bearing housing and end housing, using a 1000 volt megohmmeter. Reading must be a minimum of 1 megohm. If reading is not satisfactory, remove bearing housing and inspect insulating material for damage and renew if necessary.

18. Insert two 1/2″-13 aligning studs, Figure 21 on page 31, 180° apart in the threaded holes in the bearing cap. The purpose of the studs is to guide the bearing housing to the bearing cap. A bearing alignment disc, Figure 21 on page 31, may also be used in installing the end housing.

NOTE

Bearing alignment disc may be fabricated as detailed in the File Drawing referenced in Service Data.

19. Lift end housing and place over rotor shaft. Align bearing housing to bearing cap using the aligning studs. Being careful not to cock bearing housing on bearing, gently push end housing onto bearing until housing is snug against bearing cap. Remove aligning disc.

20. Apply new gasket to bearing cover, Figure 13 on page 18. Mount bearing cover to bearing housing with brush holder studs located at top and bottom positions. Remove aligning studs and secure cover with 1/2″-13 cover mounting bolts hand tightened. When all bolts are installed hand tight and the cover is not cocked, torque bolts to 50-55 ft-lbs (68-75 N-m) using a minimum of three passes.

CAUTION

Do not heat seal above 220°F (104°C). Overheating may result in warpage or other damage to seal.

21. Heat outer seal in an oil bath or electric oven, for half an hour at 220°F (104°C). If oil bath method is used, remove oil from seal with clean bound edge cloths prior to shrinking to rotor shaft. When using an induction heater, pyrometer readings (with current off) should be taken periodically. After heating, shrink outer seal to rotor shaft by letting it cool to room temperature.

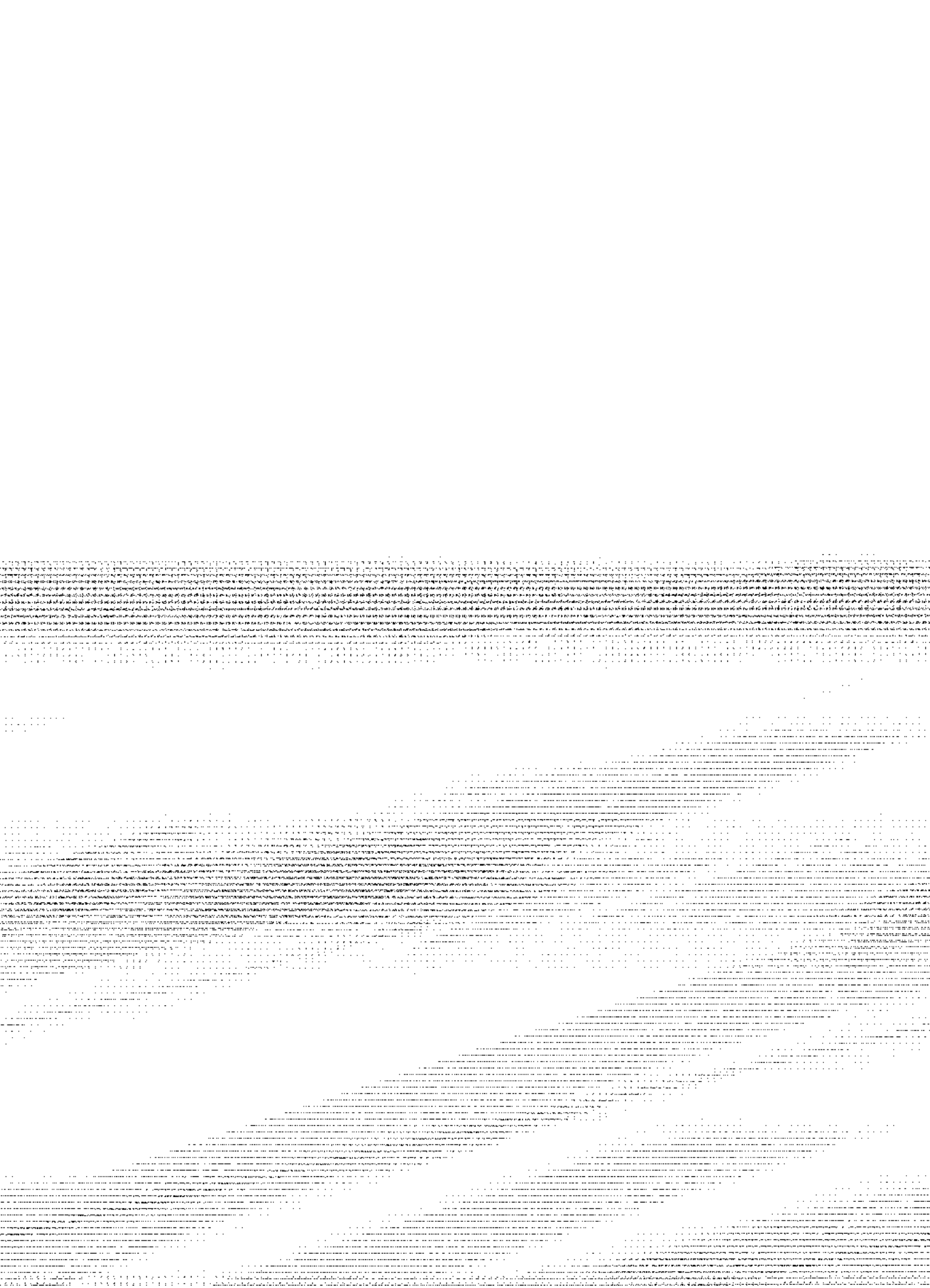
22. Place collector ring assembly on induction heater and heat to 220°F (104°C). Pyrometer readings (with current off) should be taken periodically. After heating, place collector ring assembly on rotor shaft, against outer seal. Rotate ring assembly on shaft for proper position of lead connection to terminals of ring assembly.

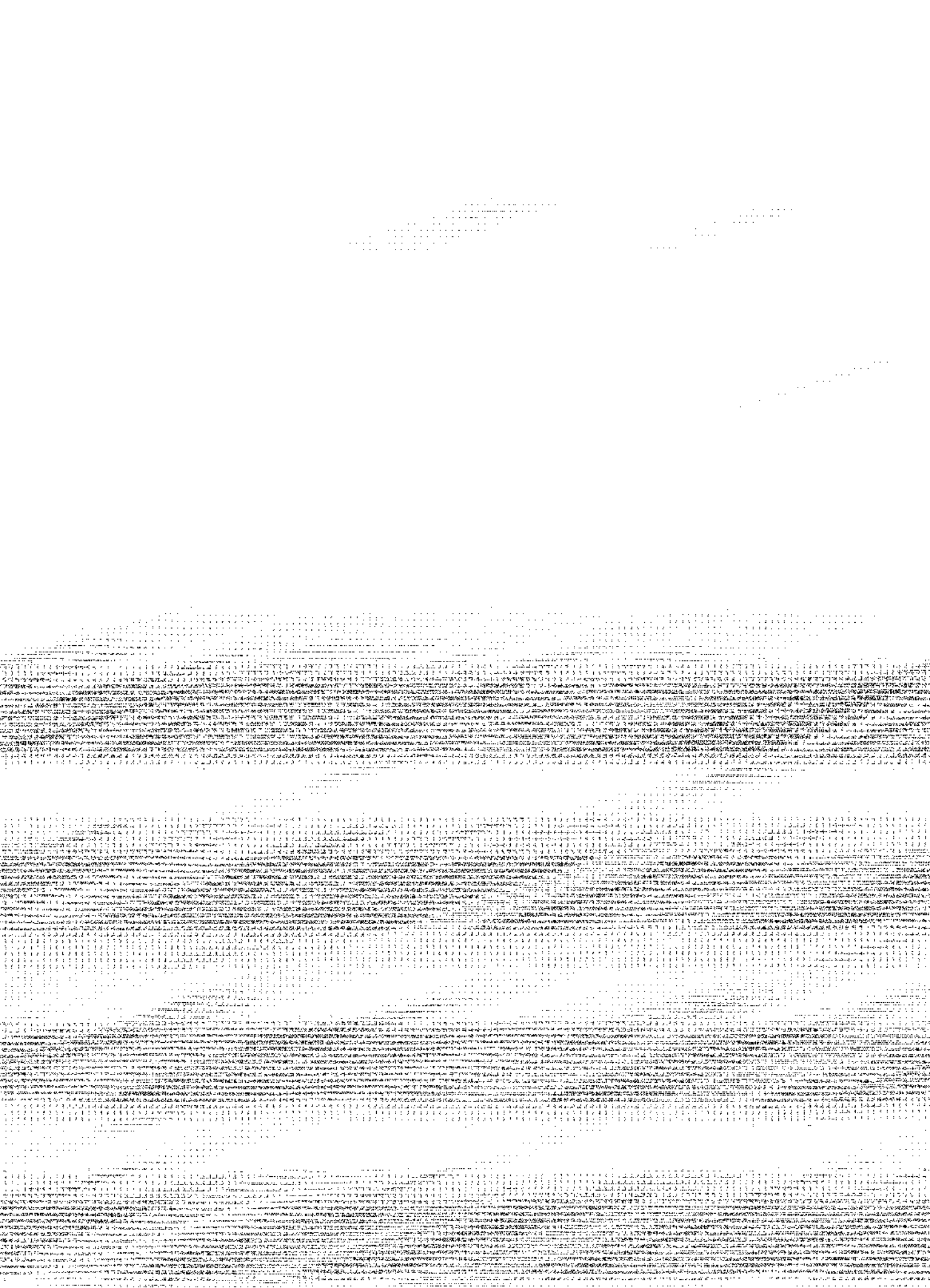
WARNING

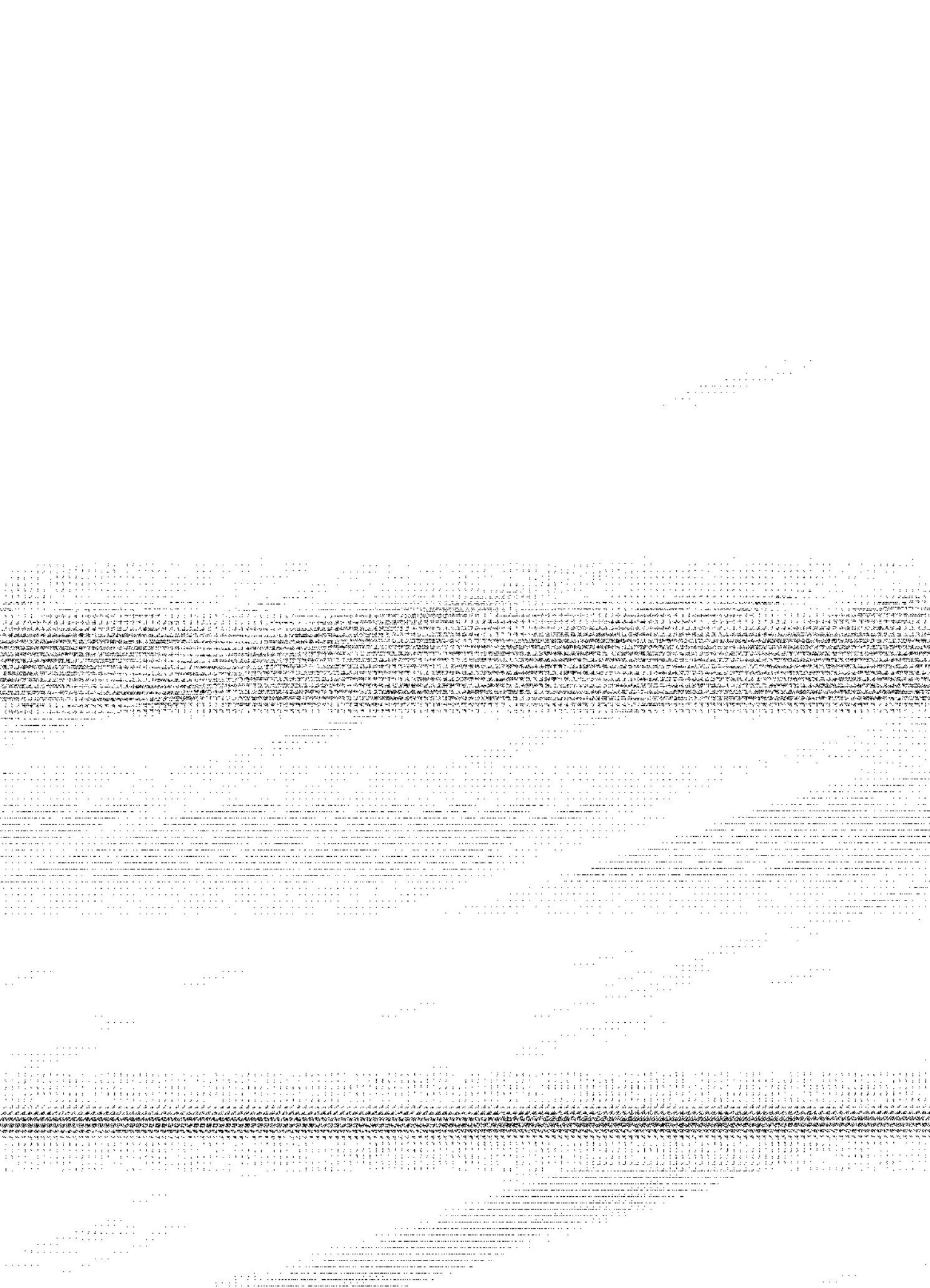
If work involving collector ring connections has been performed, use a continuity tester (with all field leads disconnected and all brushes lifted) to check that collector ring terminals marked 1 through 6 on the steel hub adjacent to the terminals are connected to the appropriate collector rings (No. 5 outboard, No. 4 inboard).

23. Place retainer plate over leads and on to the end of rotor shaft. Torque the 5/ 8″-11 retainer plate mounting bolts to 110 to 120 ft-lbs (149 to 163 N-m)

24. Install cable grommet over six field leads and insert grommet into retainer plate.







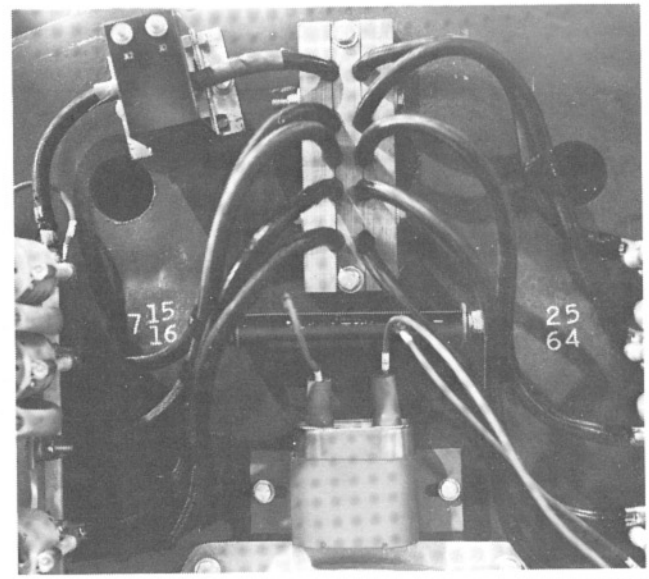


Figure 25. Stamped Dimensions On Generator End Housing

8. Position the rotor so that all the end movement is taken up in the direction of the coupling disc.

   Measure the distance from the bearing housing bolt head at the 1 o'clock position to the outer surface of the collector ring assembly, Figure 26 on page 35. This measurement is the "X" (protrusion) dimension. Stamp this measurement, to the nearest 1/64 in (0.40 mm), on the generator end housing, Figure 25.

   This dimension should be approximately 8 in (203 mm).

9. Place fish paper strips (1/16 x 3 x 36) in (2 x 80 x 900) mm in air gap between rotor assembly and stator. Remove crane cables and end housing holding fixture.

10. Install brush holders, refer to Figure 5 on page 9. Large brush holders for traction alternator over collector ring positions 3 and 4, large brush holders for companion alternator over collector ring positions 1 and 2, and small brush holders for the HEP alternator over collector ring positions 5 and 6.

11. Mount jumper leads J1, J2, J3, J4, J5, and J6 between top and bottom brush holders having the same position numbers. The jumper leads attach to brush holder locking screws, which secure holder to insulated stud.

12. Route leads to left of collector ring assembly. Secure leads with three cable clamps bolted into threaded holes in bearing housing.

13. Connect external leads 1, 2, 3, 4, 5, and 6 to corresponding lower brush holder terminals.

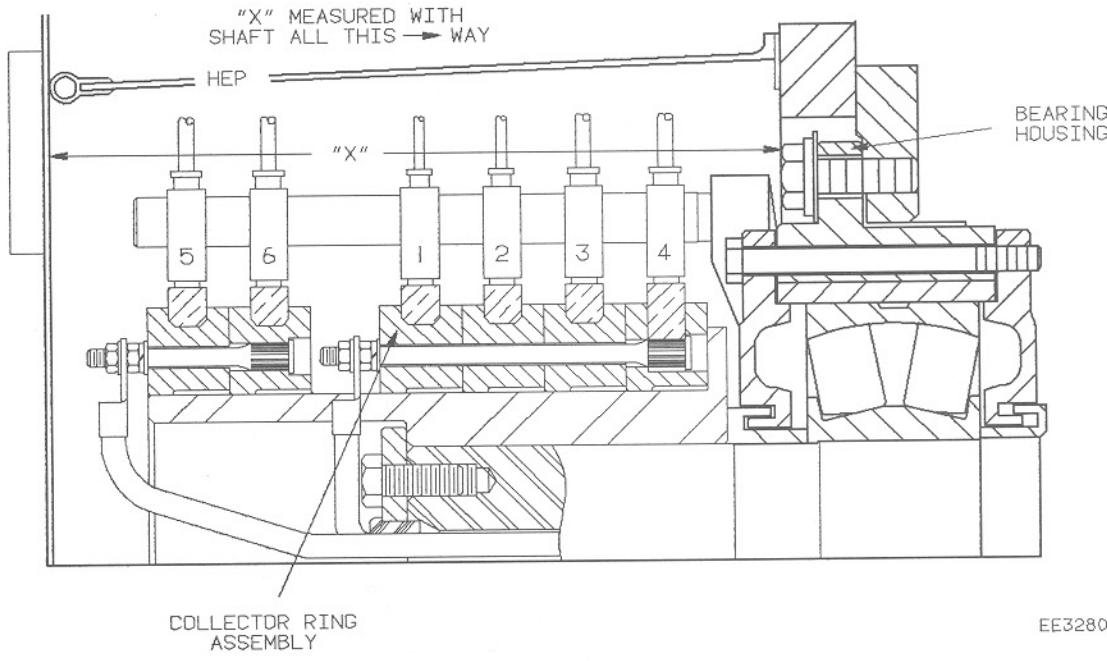


Figure 26. Bearing "X"(protrusion) Measurement

14. Adjust brush holders to have 1/8 in (3.2 mm) clearance over collector rings. In addition ensure that holder is centered over collector ring. Torque holder locking screws to 10 to 15 ft-lbs (14 to 20 N-m). Assemble brushes in holders; if used brushes are reinstalled ensure that their original positions are maintained. Check that each brush is centered within 1/ 16 in (1.59 mm) in relation to mating collector ring.

15. Install rectifier banks on end housing.

16. Install stator lead cleat assemblies to face of end housing and connect stator leads to rectifier bank assemblies.

17. Install collector ring cover and air box cover assembly removed during disassembly.

18. Connect all loose leads to proper connections and secure with tape to prevent movement. Route remaining external leads through hole on lower face of air box.

Generator is now ready to be tested, refer to Generator Testing at the back of this document. When tests are complete, refer to Installation Of Main Generator Into Locomotive Unit.

RECTIFIER BANK ASSEMBLIES AND SUPPRESSION CIRCUITS

The traction generator is a 3-phase alternator, the rotor of which makes up a 10 pole DC excited field. Two sets of "Y"- connected windings make up the alternator stator. The arrangement results in two sources of 3-phase AC that are paralleled and rectified at the heat sink mounted silicon diodes. Refer to Figure 27. There is also a separate rectifier assembly for the HEP alternator, Figure 29 on page 38.

NOTE

The **HE5** alternator has both 3-phase "Y" AC output windings connected in series, instead of parallel, to provide a higher output voltage.

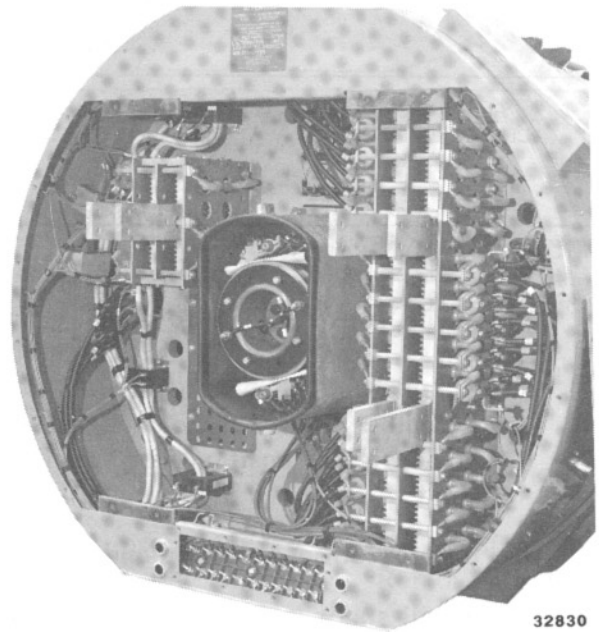


Figure 27. Main Generator Rectifier Banks

Both rectifier assemblies have a fabricated type frame as shown in Figure 28 on page 37 and Figure 29 on page 38.

Fuses are provided to isolate diodes that may become shorted, and the operating coil of a protective relay is connected across the neutral points of the stator windings to detect a single phase condition. The relay coil is also connected through resistance to ground to detect generator or locomotive grounds.

Facing the collector ring end of the machine, the traction rectifier bank assembly is on the right side and the HEP rectifier bank assembly is on the left side of the slip rings. Each assembly consists of:

1. A positive and a negative heat sink and bus bar assembly.

that phase. The output from these transformers is supplied to overcurrent and overload protection circuits.

One of the current transformers, CT4, is used to provide an additional signal proportional to HEP phase A current. This signal is required to lower the available traction horsepower reference by an amount equal to the HEP horsepower being used.

CURRENT TRANSFORMER SUMMARY

- CTA,CTB.CTC - phase A,B,C traction generator currents.
- CT1,CT2,CT3 - phase A,B,C HEP generator currents.
- CT4 - HEP traction horsepower reduction signal.

CAUTION

Some generators may be equipped with current transformers that are not used. The secondary winding of these unused current transformers must be shorted together to prevent high voltage damage to the generator.

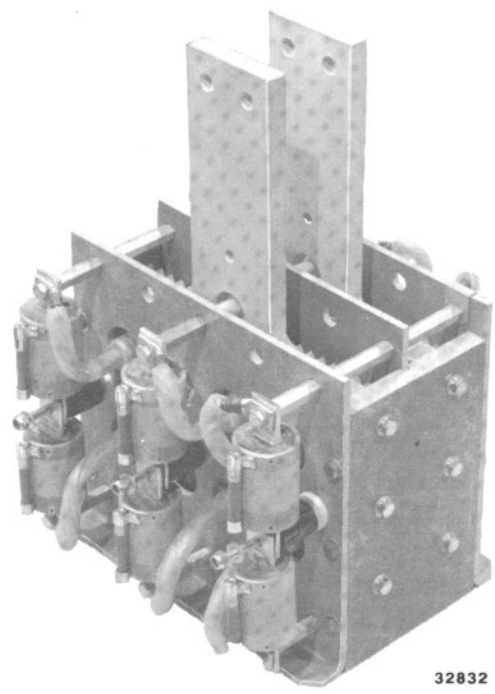


Figure 29. HEP Rectifier Bank Assembly

Figure 30 on page 40 is a simplified wiring diagram of the AR10 traction alternator and Figure 31 on page 41 is a simplified wiring diagram of the HEP alternator.

RECTIFIER BANK ASSEMBLY

The rectifier assembly should be inspected at intervals indicated in the Scheduled Maintenance Program. Refer to Figure 32 on page 43 to inspect the rectifier assembly.

CLEANING

The following procedure is recommended for cleaning the rectifier assemblies. The cleaning should be performed at the intervals stated in the Scheduled Maintenance Program.

1. Remove the heat sink assemblies from the generator.

2. Remove all fuses from rectifier banks to prevent damage to fuses during cleaning operation. If there is no visible damage to diodes, diodes should be checked in heat sinks. If there is reason to remove diodes before cleaning, inserts such as discarded diodes should be placed in diode holes to protect diode contact surface on the heat sinks. Use special diode wrench to remove diodes. Refer to Service Data for diode wrench part number.

> **WARNING**
>
> Water or cleaning solution allowed to contaminate the arc quenching sand inside the fuse body can cause the fuse to explode when it is required to isolate a shorted diode.

3. Mix a steam cleaner such as Dober Chemical Corporation Cleaner 6006 or Turco Chemical Company Steamfas in a suitable container. Use a 3 oz per gal (approx. 23 g per liter) mixture of cleaner and water and maintain a tank temperature of approximately 140 to 160°F (60 to 71°C).

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

4. Place steam gun suction pipe into the cleaning solution and regulate the gun to obtain a good soapy solution.

> **CAUTION**
>
> Do not use live steam alone to clean the assemblies, and do not soak the assemblies in a caustic solution. If diodes are removed from the heat sink, the contact surfaces of the diodes and heat sink assemblies must not be cleaned with an abrasive material or wire brush. Such cleaning will destroy the finish and reduce heat rejection capability.

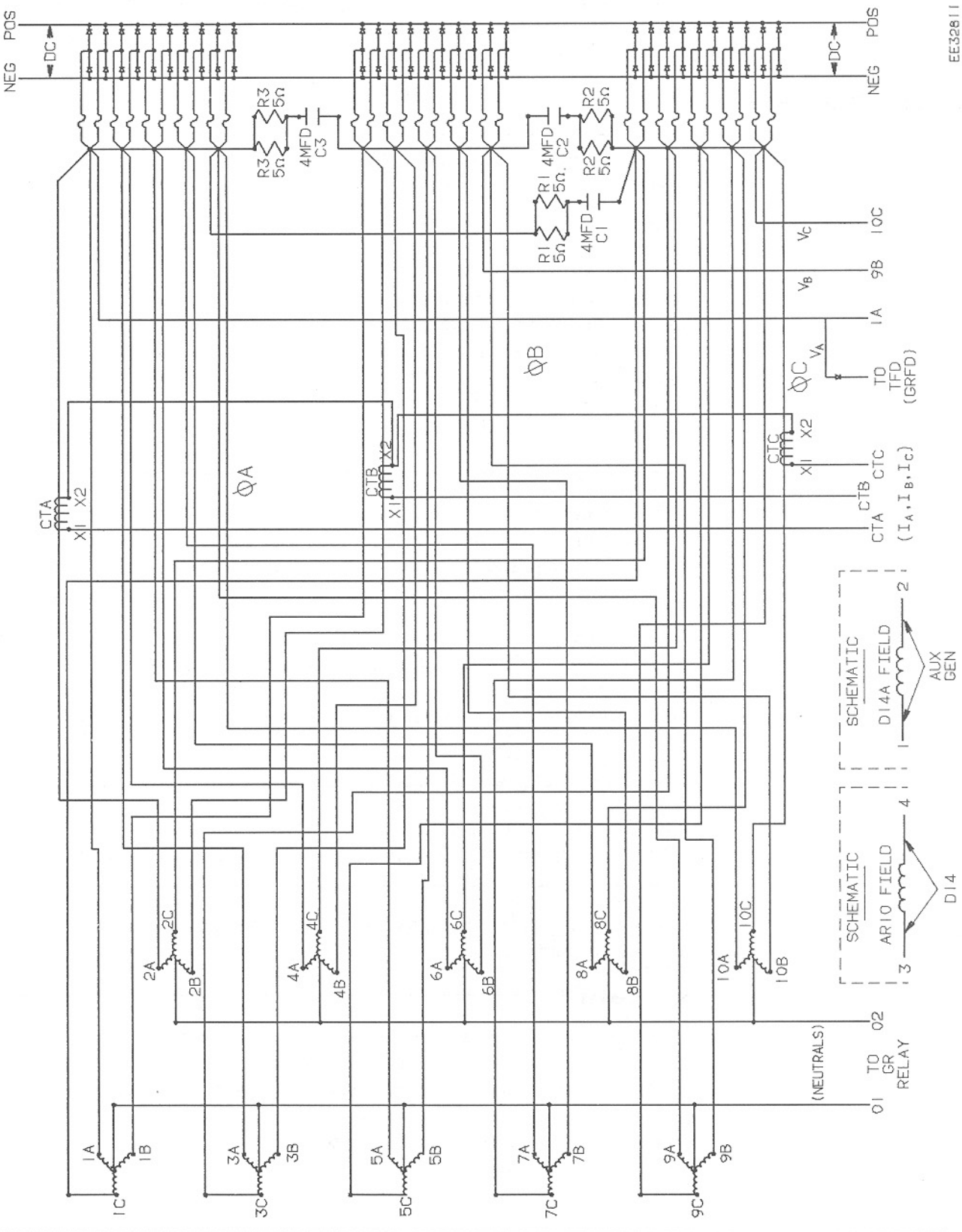


Figure 30. Simplified Wiring Diagram - Traction Alternator

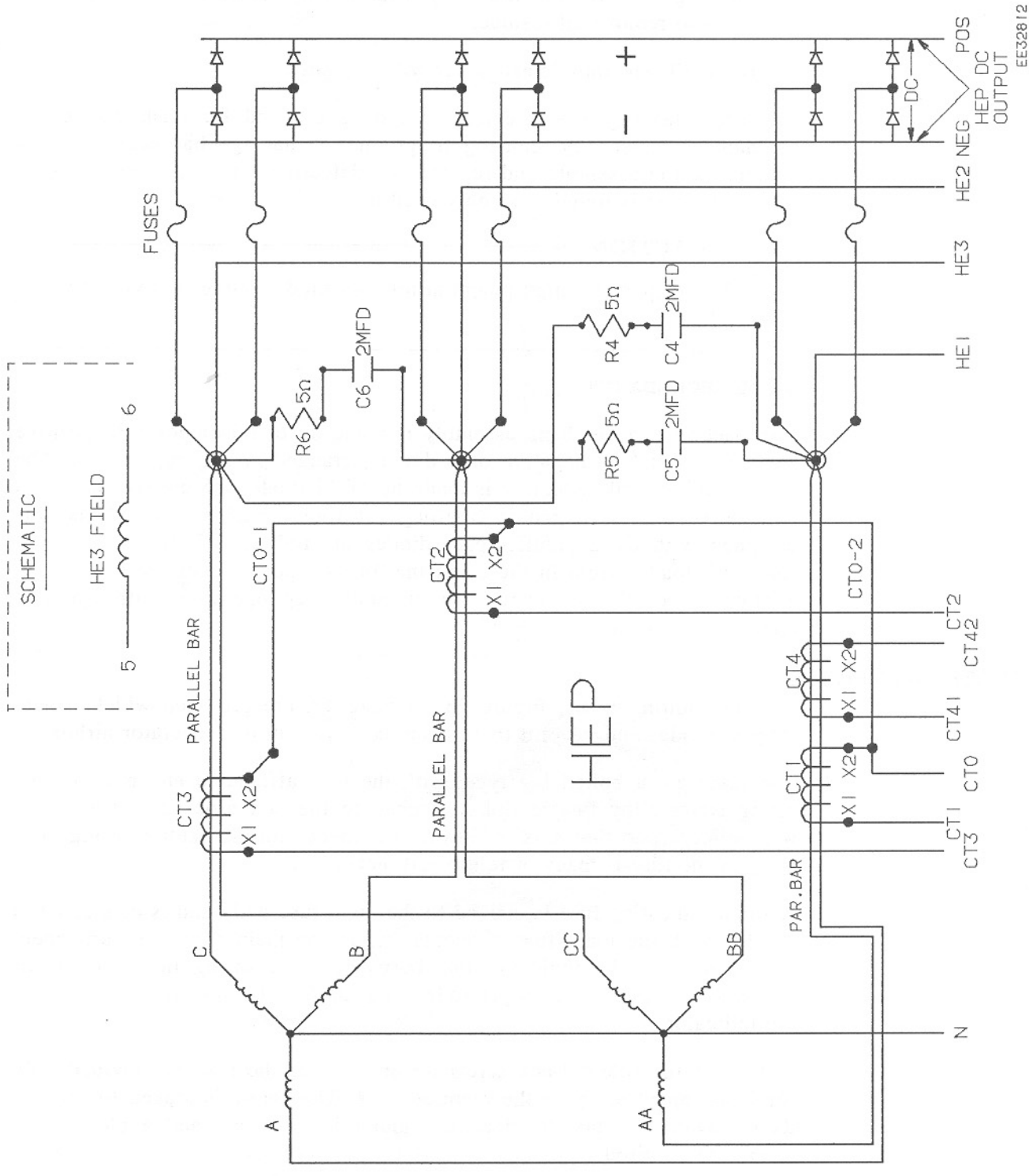


Figure 31. Simplified Wiring Diagram - HEP Alternator

5. Clean all parts of the heat sink assembly, keeping the gun nozzle 4 to 6 in (100 to 150 mm) from the work.

6. Thoroughly rinse the assembly with a low pressure stream of clean water to remove all residue.

7. Blow off remaining clean water with dry air.

8. After cleaning, the assembly should be checked for flash damage or damage caused by shorting to ground. If damage has occurred, dismantle the assembly and replace any defective parts with new parts. If no damage is found, assembly need not be dismantled.

> **CAUTION**
>
> Do not perform high potential tests on diodes, either individually or collectively.

DIODE REDUNDANCY

The traction rectifier bank assembly is made up of 60 diodes : 30 positive base diodes and 30 negative base diodes arranged in 3 groups of ten. The HEP rectifier bank assembly is made up of 12 diodes : 6 positive base and 6 negative base arranged in 3 groups of four. Each rectifier bank was designed with extra parallel path diodes or "redundant" diodes that will carry full load current in the event that one or more diodes are isolated by a blown fuse. The generator can maintain load operation with approximately 40 % of diodes isolated.

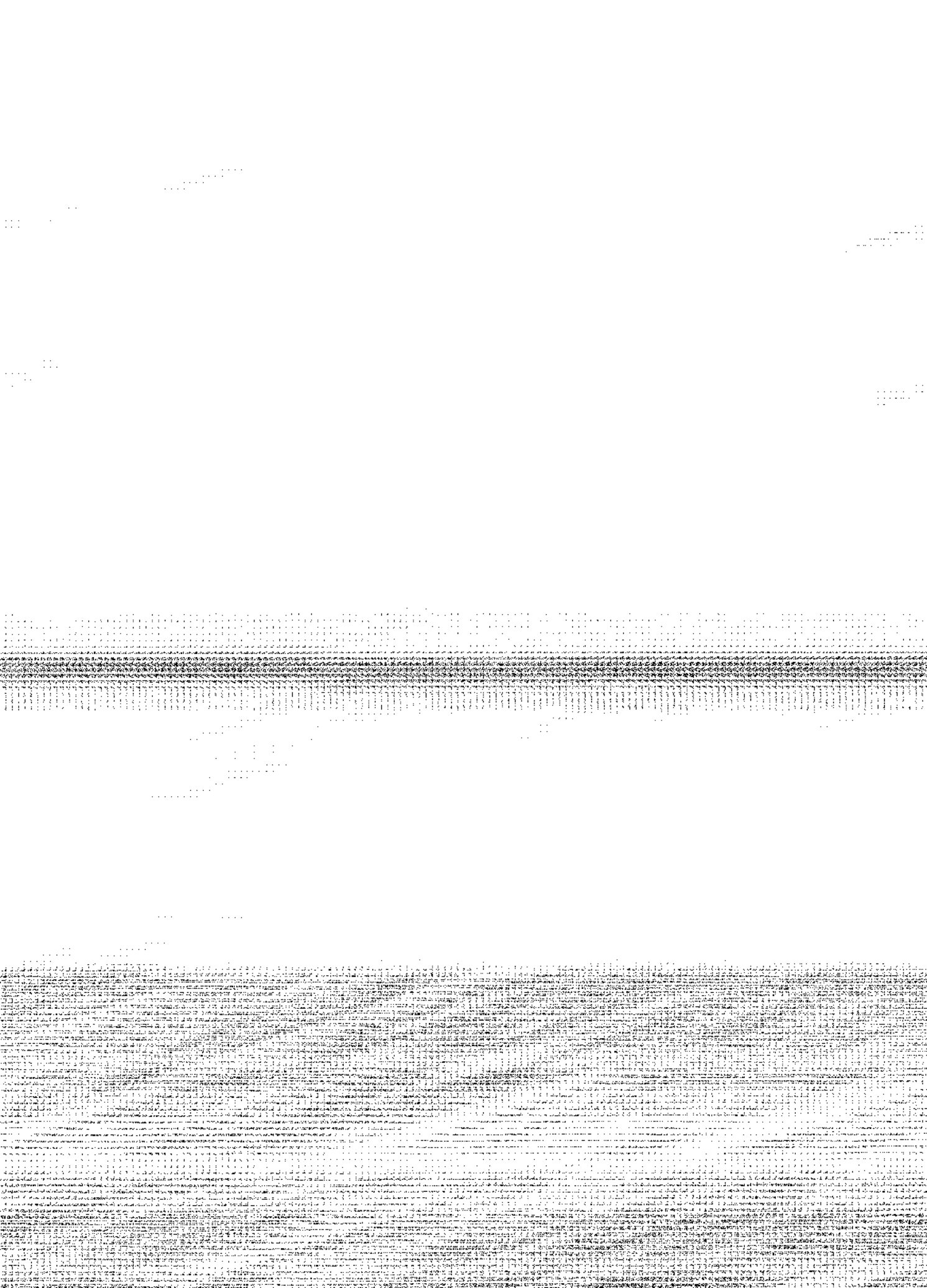
PROTECTIVE FUSES

Current limiting fuses, Figure 33 on page 43, are provided which isolate shorted diodes and prevent them from exploding in the generator airbox.

The fuses are a bolted lug type, with the lugs affixed to end blocks. Fast acting silver alloy fusible links attached to the end block are surrounded with silicon sand that acts to absorb arc energy during fault clearing. The body of the fuse is made of reinforced melamine.

A small indicating fuse is affixed to the main fuse body and is connected in parallel with the main fuse elements. When the main elements burn open, the element of the indicator also burns open. A spring in the indicator drives an indicating pin to protrude about 3/16 in (5 mm) from the end of the indicator.

Note that the internal-hex screw on one end of the fuse is provided only for insertion of sand by the manufacturer. The screw is staked to prevent its removal. The fusible elements cannot be renewed, and a blown fuse cannot be repaired.



NOTE

Two different fuses are used in this generator - each with a different resistance value. The traction rectifier bank uses a lower resistance value fuse to allow a higher current value before opening and the HEP rectifier bank uses a higher resistance value fuse.

Traction Rectifier Bank Fuse (30) 8407729

HE3 Rectifier Bank Fuse (6) 40017954

HE4 Rectifier Bank Fuse (6) 40020320

HE5 Rectifier Bank Fuse (6) 40022165

DIODE TESTING AND REPLACEMENT

The following procedure was developed for testing and replacement of rectifier bank diodes with the assumption that at least one indicating pin is protruding. Refer to Figure 34

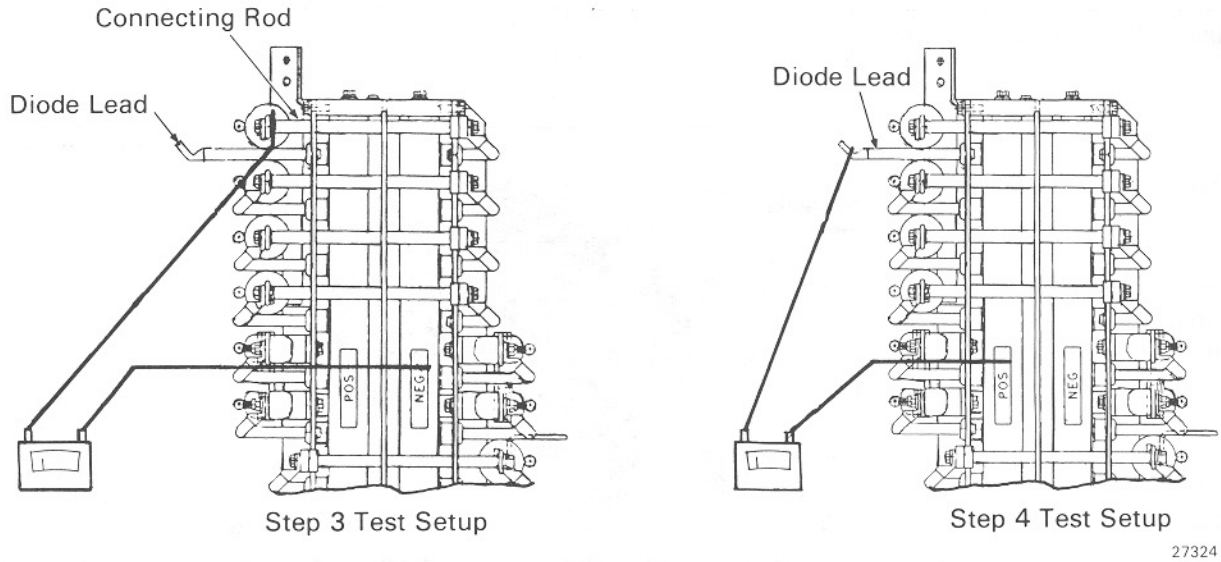


Figure 34. Diode Inspection And Replacement

1. Indicating pin protrudes.
2. Remove bolt and unfasten diode lead. Check fuse continuity.

NOTE

If multiple failures have occurred in a single group of diodes. or if repeated failures have been observed in a single group of diodes. isolate and check all diodes in the group.

3. Place continuity tester across negative bus and connecting rod, then switch the tester leads. This checks one of the diodes. If diode is good, then the meter registers a low resistance reading in one direction and a higher resistance reading in the other direction.

NOTE

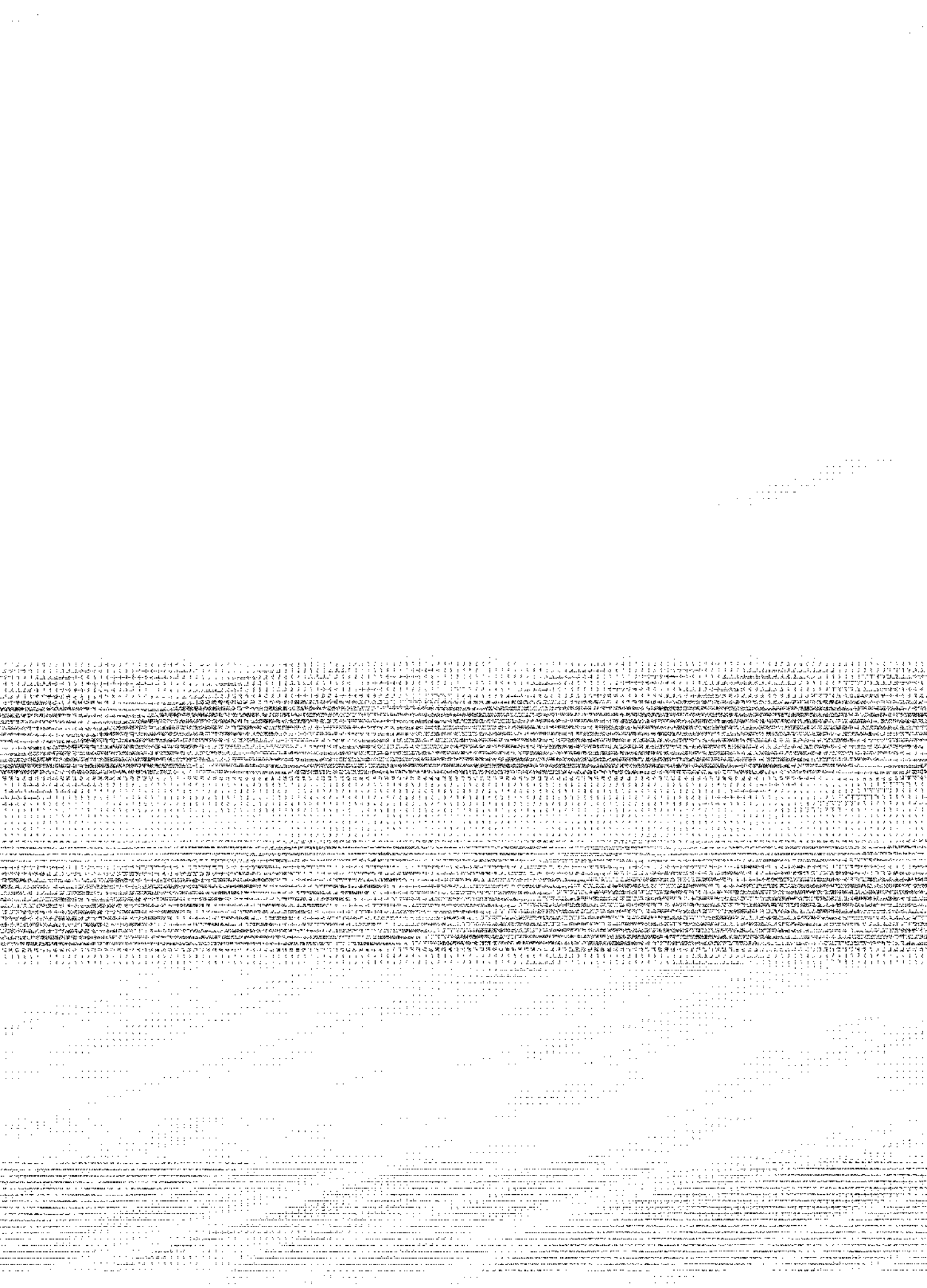
If the resistance reading for a diode is the same in both directions, then it is an indication that the diode has failed and should be replaced.

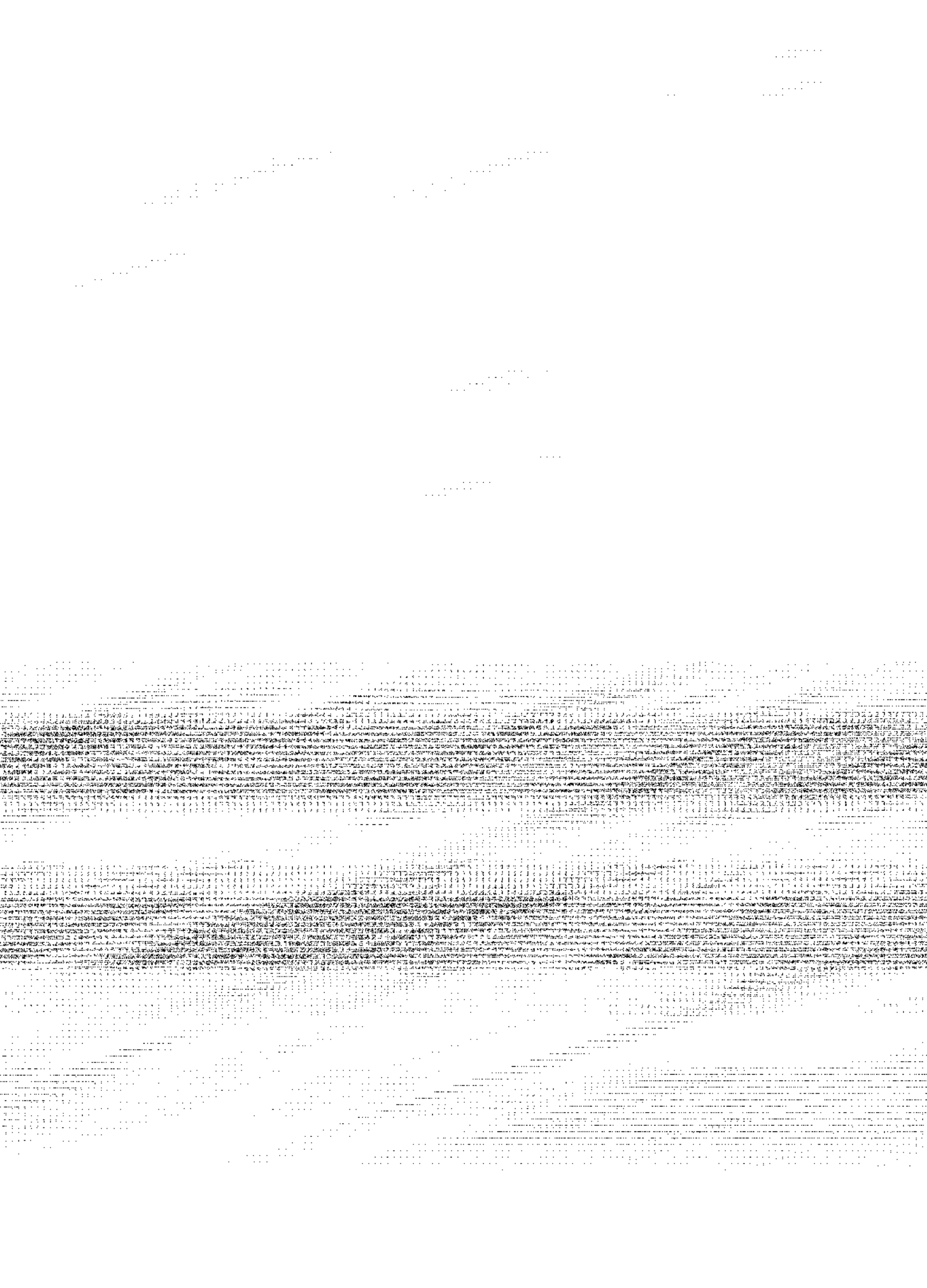
4. Place continuity tester across positive bus and diode lead, then switch the tester leads. This checks the other diode.
5. Replace blown fuse with a good fuse.
6. Remove any defective diodes, using special diode wrench 8361524.
7. Wipe the diode mounting surface of the heat sink bus. Do not use abrasive material.
8. Replace defective diodes with good diodes of identical type, polarity, and voltage class (or higher voltage class). Apply a thin coating of compound 8346481 to the base of the diode hex to cover the surface. Do not apply on threads.
9. With special diode wrench and 0 to 50 ft-lb torque wrench, torque diodes to 32 to 35 ft-lbs (43 to 47 N-m). Make certain that the wrench is properly seated when torquing.
10. Torque diode terminal lug bolts to between 11 to 13 ft-lbs (15 to 18 N-m).
11. Replace and securely fasten all air box panels and inspection covers.

DIODE CLASSIFICATION

For service purposes the following classifications of generator diodes are significant.

1. Polarity with respect to the diode base (threaded stud). A color code is used to assist in identification.
2. Type with respect to forward voltage drop. Identification is assisted by color code and by type number impressed into the base.
3. Voltage class in respect to repetitive and non - repetitive peak inverse voltage rating. Identification is assisted by color code. Diode service





The voltage class used in a specific generator is dependent upon the type of service in which the generator is employed and upon specific characteristics of the control system that is used.

MANUFACTURER'S QUALIFICATION MARKS

A variety of qualification marks. have been placed upon diodes by the manufacturer. For example; small color dots on the diode body, large color spots (not bands) on the diode body or lug, color marks at the edge of the lug, and numbers stamped onto the diode body. These marks are for manufacturer's identification only.

The only significant marks for service purposes are:

1. The color band 360 degrees around the lug barrel at the end of the flexible lead.
2. The color band 360 degrees around the crimp at the flexible lead and diode body.
3. The service part number printed on the cap of the diode body.
4. The color of the ceramic insulator.
5. The diode type number stamped into the flat end of the threaded stud.

ALL OTHER COLOR SPOTS AND STAMPINGS SHOULD BE DISREGARDED.

DIODE IDENTIFICATION

Figure 37 on page 51 illustrates the identification markings for the diodes used in this generator and Table 1 lists them according to part number.

Table 1. Diode Identification

Part Number	Voltage Class	Lug Barrel Color Band	Polarity Of Base	Ceramic Color	Diode Type	Body Crimp Color Band
8368466	2000/2400	Green	Positive	White	2	Red
8368468	2000/2400	Green	Negative	Pink	2	Red
8447654	2200/2800	Blue	Negative	Pink	2	Red
8447655	2200/2800	Blue	Positive	White	2	Red

DIODE MATCHING

The traction rectifier assembly has diodes and fuses paralleled in groups of five with paralleling bars. The HEP rectifier assembly has diodes and fuses paralleled in groups of three with paralleling bars.

Diodes used in the generator must be matched as follows:

1. Polarity

   All diodes in any paralleled group must be of the same polarity (ceramic cases must be of the same color), and the diodes must be

applied to the proper heat-sink bus. Negative base (pink) diodes to negative bus, and positive base (white) diodes to positive bus. Bus polarity is stamped into the end of the bus.

2. Type

   All diodes in this generator model must be of the same type (TYPE 2) - same impressed type number and same type color band at the lower crimp.

> **CAUTION**
>
> MIXING OF TYPES WILL CAUSE UN-EQUAL LOAD SHARING AND MUST BE AVOIDED.

   Observe that hexagonal connecting rods do not connect diodes in parallel; therefore, diodes connected by rods do not necessarily match by type.

> **NOTE**
>
> Generators are equipped with Type 2 diodes, and only Type 2 diodes may be obtained as replacement parts.
>
> lf due to operating conditions mixing of types cannot be avoided, a replacement diode of the next higher type number may be used for a temporary emergency fix. This diode should be replaced with the proper type diode at the earliest opportunity.

3. Voltage Class

   All diodes in a generator must equal or better the inverse voltage rating (voltage class) required for the particular application.

> **NOTE**
>
> This model main generator is equipped with 2400 volt (GREEN band) diodes in the traction rectifier bank and 2800 volt (BLUE band) diodes in the HEP rectifier bank.

COMMUTATION TRANSIENT VOLTAGE SUPPRESSION

The action of diodes switching from a conducting to a blocking state in the generator is called commutation. During commutation, high reverse current flows in the diodes for a few microseconds, after which time the value of reverse current flow in the diode suddenly drops to almost zero. The rate at which current flow changes from a high value to almost zero, multiplied by circuit inductance determines the magnitude of the transient voltage spike. If this transient voltage exceeds the reverse rating of the diode, the diode will immediately fail.

The generator is provided with a system for capacitive storage of energy from circuit inductance during commutation. The system is called the commutation transient voltage suppression system.

This supression system is required to protect the rectifiers from commutation transients. A separate suppression system used for the traction rectifier system and for the HEP rectifier system. The traction suppression system is shown in Figure 38 on page 52 and the HEP suppression system is shown in Figure 39 on page 53.

PCB (polychlorinated biphenyl) capacitors contain a toxic environmental contaminant requiring special handling and disposal in accordance with U.S. Environmental Protection Agency Regulations 40 CFR 761. For disposal information contact the nearest U.S. EPA Office.

WARNING

When replacing capacitors, non-PCB capacitors must be used. PCB capacitors are no longer available as replacement parts.

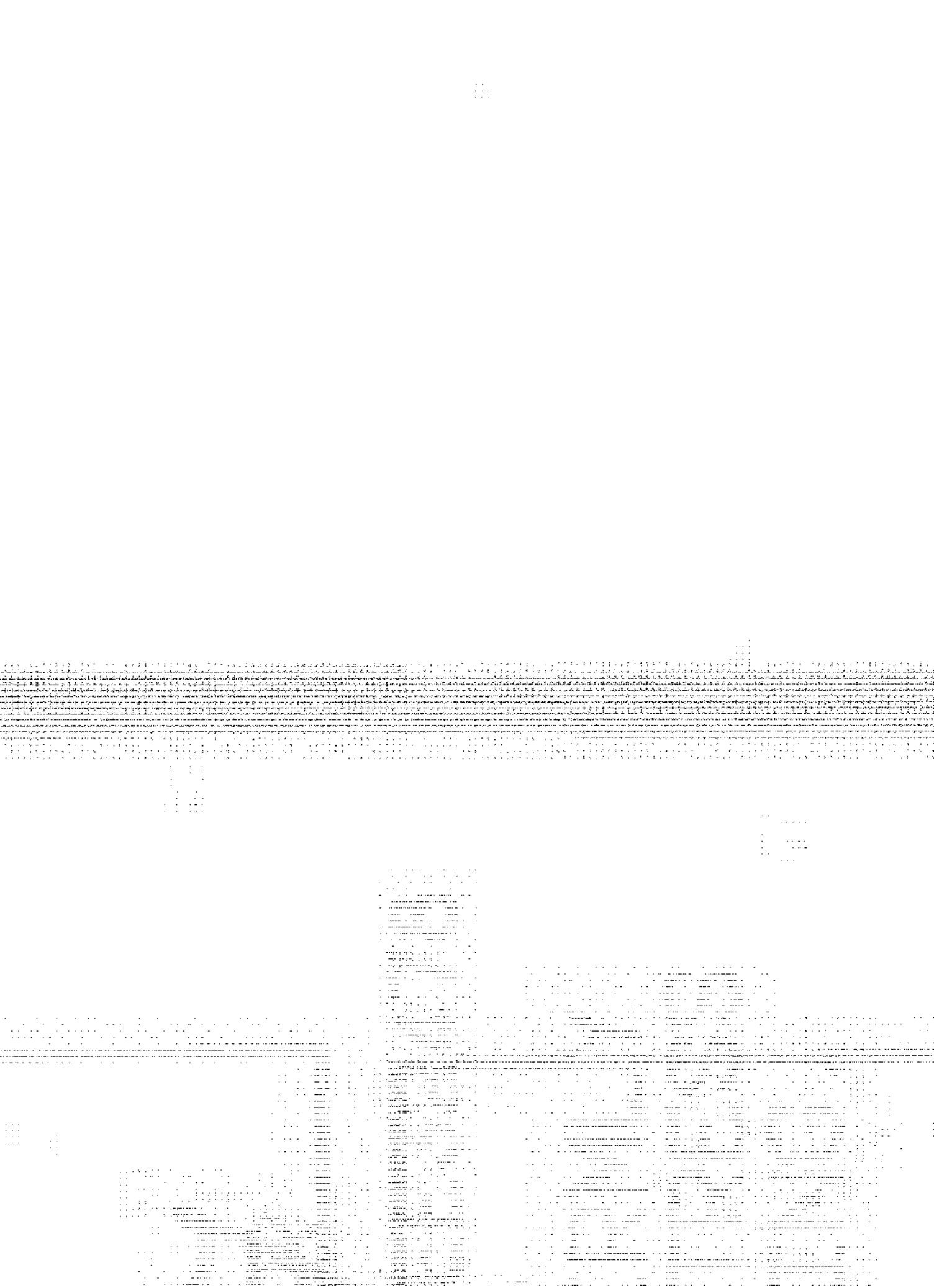
Original PCB Capacitor	Replace With Non-PCB Capacitor
8380921	9332014
*8442069	*9332014
8411555	9332016
8352261	9503808

TRACTION SUPPRESSION SYSTEM

The suppression system for the traction rectifiers, Figure 38 on page 52, uses a 4 microfarad capacitor and a 2.5 ohm resistor connected in series. These in turn are connected between the "A", "B", and "C" phase paralleling bars on both the left and right banks of the generator.

HEP SUPPRESSION SYSTEM

The suppression system for the HEP rectifier banks Figure 39 on page 53, uses a 2 microfarad capacitor and a 5 ohm resistor connected in series. These in turn are connected between the "A," "B," and "C" phase paralleling bars on both the left and right banks of the generator.



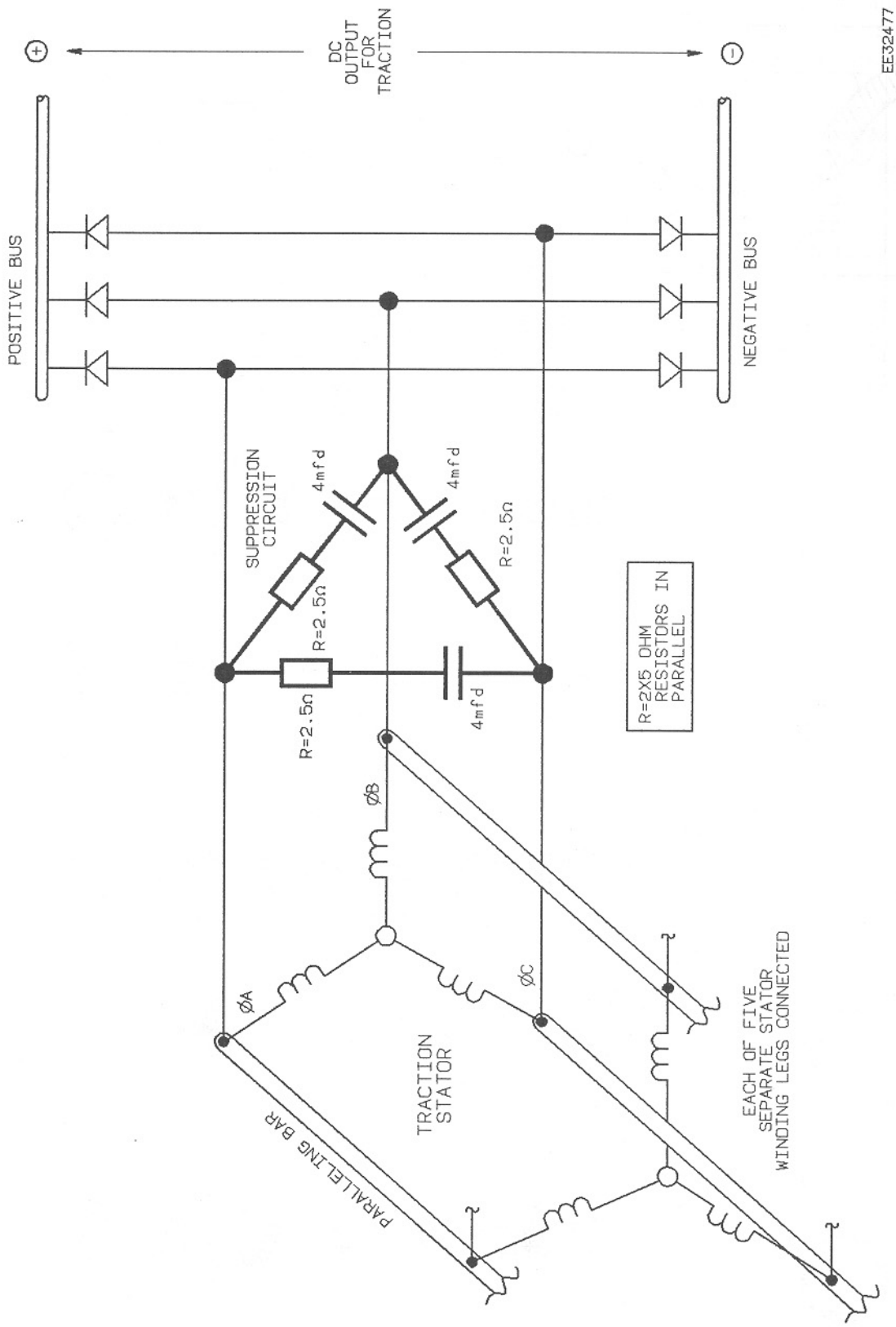


Figure 38. Suppression Circuit For Traction Rectifier Banks

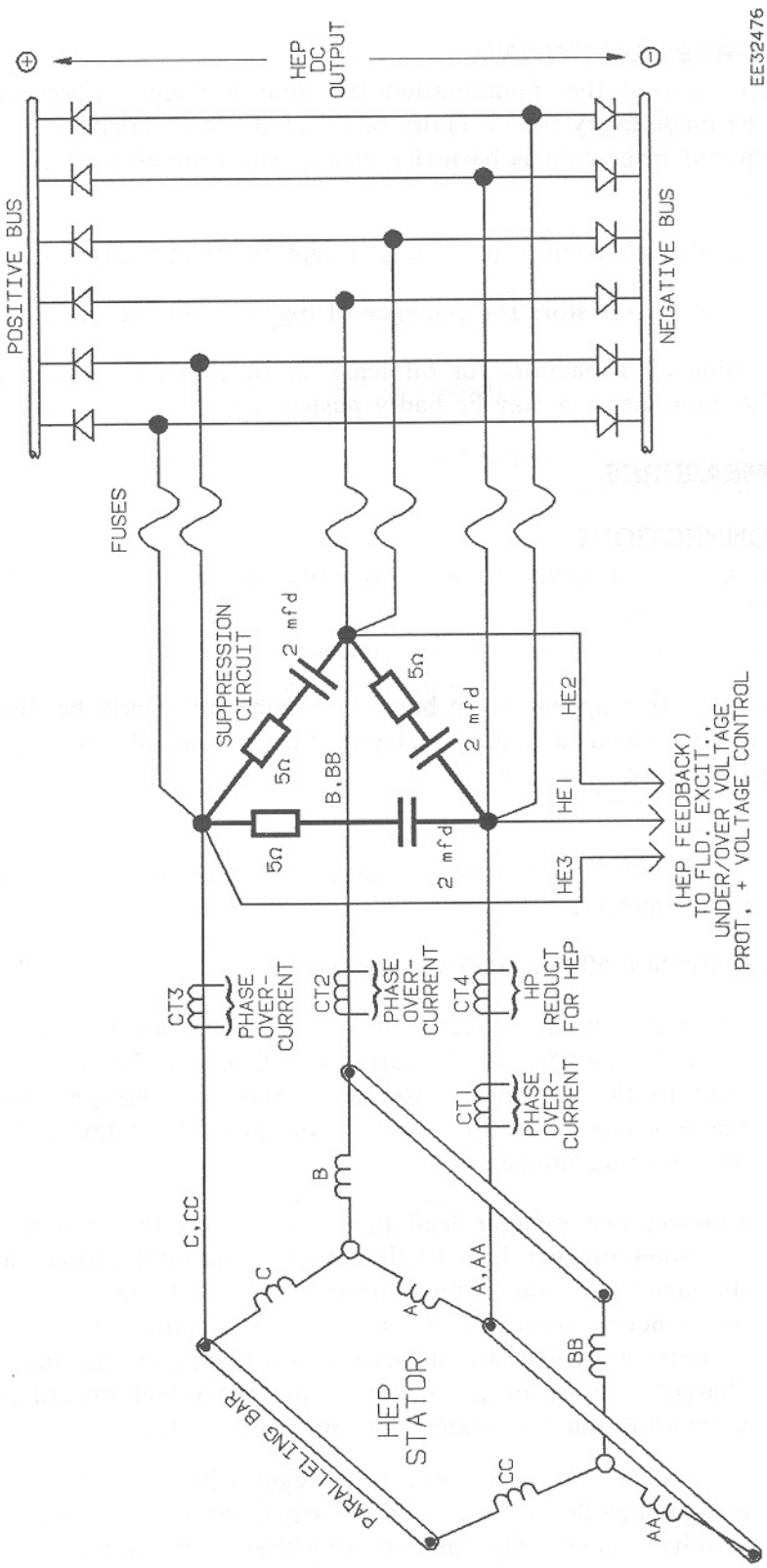


Figure 39. Suppression Circuit For HEP Rectifier Banks

TESTING OF EQUIPMENT

INSPECTION OF THE SUPPRESSION SYSTEM

An inspection of the commutation transient voltage suppression system should be made every time a faulty or failed diode is detected and replaced. The required inspection is basically visual. The following checks should be made.

1. Check that all connections are tight and are electrically correct.
2. Examine all resistors for evidence of overheating and open turns.
3. Examine all capacitors for oil leaks or deformation of the container. (The container top may be badly pushed out.)

TEST AND CORRECTIVE MEASURES

LOOSE OR IMPROPER CONNECTIONS

Tighten any loose connections in accordance with the applicable wiring diagram.

DAMAGED RESISTORS

Any resistors that appear to be burned or damaged should be disconnected and continuity checked. Faulty resistors must be immediately replaced with qualified resistors.

DEFECTIVE CAPACITORS

If a capacitor is suspected faulty, it should be disconnected and checked in the following manner.

1. Checks with a 500 or 1000 volt megger.

   A. Short circuit the capacitor terminals and connect the positive lead from the megger to the terminals. Connect the megger negative lead to the capacitor case, and rotate the megger handle. The reading should be 25 megohms or more. Disconnect the megger and shorting jumper.

   B. Connect one megger lead to one capacitor terminal and connect the other megger lead to the other capacitor terminal, and rotate the megger handle. If the capacitor is good, there will be a definite meter needle deflection toward zero (indicating capacitor charging current) followed by a drift toward infinity as the capacitor charges. Failure of the meter needle to deflect toward zero is an indication that the capacitor is open internally.

      If the capacitor is shorted, the megger will indicate zero when the megger handle is rotated. If the capacitor is open, it will indicate infinity immediately upon rotating the handle, and the reading will drop to zero when the rotation of handle is stopped.

CAUTION

Carefully discharge the capacitor after the check by using a screwdriver with an insulated handle to short across the capacitor terminals.

2. If only a 500 volt megger is available, and megger checks indicate a good capacitor but the condition of the capacitor is still suspect (burn spots appear on resistors associated with the capacitor), use a 64 VDC input, 1200 VDC output MG set as a high potential tester to induce possible flashover within the capacitor.

   A. Connect the positive output lead from the MG set to one terminal of the capacitor. Connect the negative output lead from the MG set to the other capacitor terminal. Connect a 0-1500 VDC meter to read MG set output voltage. Connect MG set input to a 64 or 74 VDC source.

   B. Advance MG set output voltage. The meter needle will advance as the MG set handle is rotated. If a flashover is induced in the capacitor, the meter needle will dip toward zero, indicating a bad capacitor. Immediately reduce voltage to zero, then turn off the MG set.

      If the capacitor is good, voltage will remain at the high output value from the MG set. Reduce MG set voltage to zero, then turn off the set.

CAUTION

Carefully discharge the capacitor after the check by using a screwdriver with an insulated handle to short across the capacitor terminals.

1. Prepare generator for testing by performing the following preliminary steps:

   A. Clean out and inspect generator for stray material, steel cuttings, etc.

   B. Disconnect suppression circuitry from rectifier bridges and AC paralleling bars.

   C. Current transformers should be short circuited by securely bolting together leads CTA, CTB, CTC, CT0, CT1, CT2, CT3, CT41, and CT42 on outside of the air box.

2. Take COLD {167°F (75°C)} resistance readings. Refer to Service Data for limits.

ELECTRICAL INSULATION TEST

Before the generator is assembled, it is advisable to electrically qualify the stator and rotor. The following qualifications should be met before any attempt to give the stator or rotor a high potential test. This applies to any stator or rotor that has had an occasion for windings to accumulate moisture or dirt.

1. Stator and rotor must be clean.

2. Stator and rotor must show a steady insulation resistance reading for at least three hours at any given temperature from 167°F to 194°F (75°C to 90°C).

3. The ratio of insulation resistance taken 5 minutes after starting the megger check should not be less than 1-1/2 times the reading taken 10 seconds after starting the check. The check should be taken with a stator temperature reading of 122°F (50°C).

4. The insulation resistance of the rotor must be not less than one megohm at any temperature up to 167°F (75°C).

Any stator or rotor which, although clean, shows low or erratic insulation resistance readings, should be dried at 194°F (90°C) until a stabilized insulation resistance reading is obtained for a period of twenty-four hours. Before applying high potential test, all the other qualifications outlined must be met.

NOTE

Generators which have been stored for a considerable period of time should be given an insulation resistance check before being put into service.

HIGH POTENTIAL TEST

The insulation used in these generators is designed to withstand somewhat higher voltages than those experienced during normal operation.

High potential tests are normally used when it is necessary to qualify new equipment installations or to determine the location of an insulation breakdown on older equipment. High potential tests can be destructive to equipment being tested and, therefore, are not recommended as a normal routine maintenance item.

In some cases, such as; national or local code requirements, company policy, or a suspected insulation breakdown, high potential tests are required. In these instances adhere to all cautions, listed below in the Safety Precautions section, while performing test.

If the rotor or stator fail the high potential test it is recommended that it be returned to Electro-Motive Division because of special tooling and facilities required to make repairs.

If the stator and rotor meet the listed qualifications, test should be taken at 122°F ± 9°F (50°C ± 5°C) in the following manner:

1. For stators, short all positive and negative bus bars.

2. Apply 1050 volts RMS to stator for one minute.

3. Apply 300 volts to rotor for one minute.

If the stator or rotor fails to qualify either the resistance check or the high potential test, the generator should be returned to the Electro-Motive Division due to the special tooling and facilities needed to make corrections.

If a high potential test is to be performed on the locomotive or generator, all positive and negative generator buses must be shorted together, and the brushes at the collector rings connected together to prevent high potential from being applied to the controlled rectifier assembly SCR.

NOTE

Operation of the generator without load is not recommended, and should be restricted to an absolute minimum; but under no circumstances allow no-load voltage to exceed 800 VDC, and never operate the generator with the inspection doors open or panels removed.

SAFETY PRECAUTIONS

- Whenever possible, high potential tests should be performed by one man. All others should be kept away from the test area.

- A thorough knowledge and understanding of equipment, and procedures involved is essential.

- To prevent dangerous overvoltage surges, test electrodes must be firmly connected to item under test before voltage is applied. In addition, the voltage should be removed before the electrodes are removed.

- Discharge residual voltage to ground after removing tester.

Before high potential tests are made, it is highly desirable to check first with a 1000 volt megohmmeter. A megohmmeter reading of 1 megohm, when tested with a megger, is satisfactory for hi-pot test. An accumulation of dirt and moisture sometimes is sufficient to cause leakage and, if high potential is applied, it will cause an actual breakdown of the insulation. The condition may be aggravated by sudden temperature changes. If the equipment has been standing outside during cold weather before being brought inside a warm building, the equipment will tend to sweat and the condensed moisture will aid the leakage effect.

The normal voltage of EMD main generators is 600 volts. Therefore, the minimum test voltage should be:

```
Generator ..................................... 950 volts
High voltage wiring and equipment ............. 1050 volts
```

In making high potential tests, the following precautions should be taken.

WARNING

Make sure that all personnel are in the clear before applying voltages.

1. All high potential tests must be made by placing electrodes on the circuit under test before closing switch, and opening switch before removing electrodes. Dangerous over-voltage surges may result from making or breaking the high voltage circuit with the electrodes.

2. It is of utmost importance, that a reliable high potential tester be used to ensure that an adequate test is made, and that unnecessary over-stressing of insulation does not take place. In regard to the features which should be incorporated in a high potential tester, the following points are pertinent:

   A. Wave form

   B. Surges

   C. Voltage regulation

INSTALLATION OF MAIN GENERATOR INTO LOCOMOTIVE UNIT

The installation of the main generator is similar to removal, with the exception that it requires more time, care and skill.

Before a main generator is installed, check and clean the mounting plates. Be sure these plates are smooth, free of burrs and high spots.

Before lifting the generator into the unit, check and clean the mounting pads on the locomotive bed frame. Be sure these pads are clean and free of burrs.

Check the surface on the engine and generator coupling discs, both must be smooth and clean. Add a little oil or mounting compound to the fitting surfaces. Check that bolt holes in couplings are clean and smooth.

Apply 2-3/8″ socket wrench to the engine and generator coupling bolt nuts to make sure they are tightened to the proper torque as specified in Service Data.

Inspect and clean shims. Shims must be smooth, free from burrs and kinks. Shims should have been tagged after removal of generator so they may be installed in their original position at this time.

Lift generator and guide slowly and carefully into engineroom. Set generator on mounting pads as close to engine coupling disc as possible.

Line up hole patterns in the engine and generator coupling discs by barring or jacking engine over. Push generator toward engine until engine coupling fits into the beveled groove in the generator coupling disc.

Check all coupling bolts to see that they are smooth and clean. Place a little oil or mounting compound on 3/4″ coupling bolts and install all bolts through the generator and engine coupling discs from the engine side. Check to be sure the generator coupling is not cocked and is properly mated to the engine coupling disc.

Once the generator is attached to the engine, do not bar or jack engine over until all fish paper strips are removed from between the rotor assembly and the stator coils.

Line up dowel holes and base bolt holes. Do not insert dowels or base bolts until generator is aligned with engine. See M.I. 1753 for alignment of generator to engine. Install dowels and base bolts. Use Texaco Threadtex as a lubricant on the bolts and washers.

GENERATOR WIRING DIAGRAM

A typical wiring diagram for a model AR10JBA-HE3-D14A generator is provided in Figure 40 on page 60.

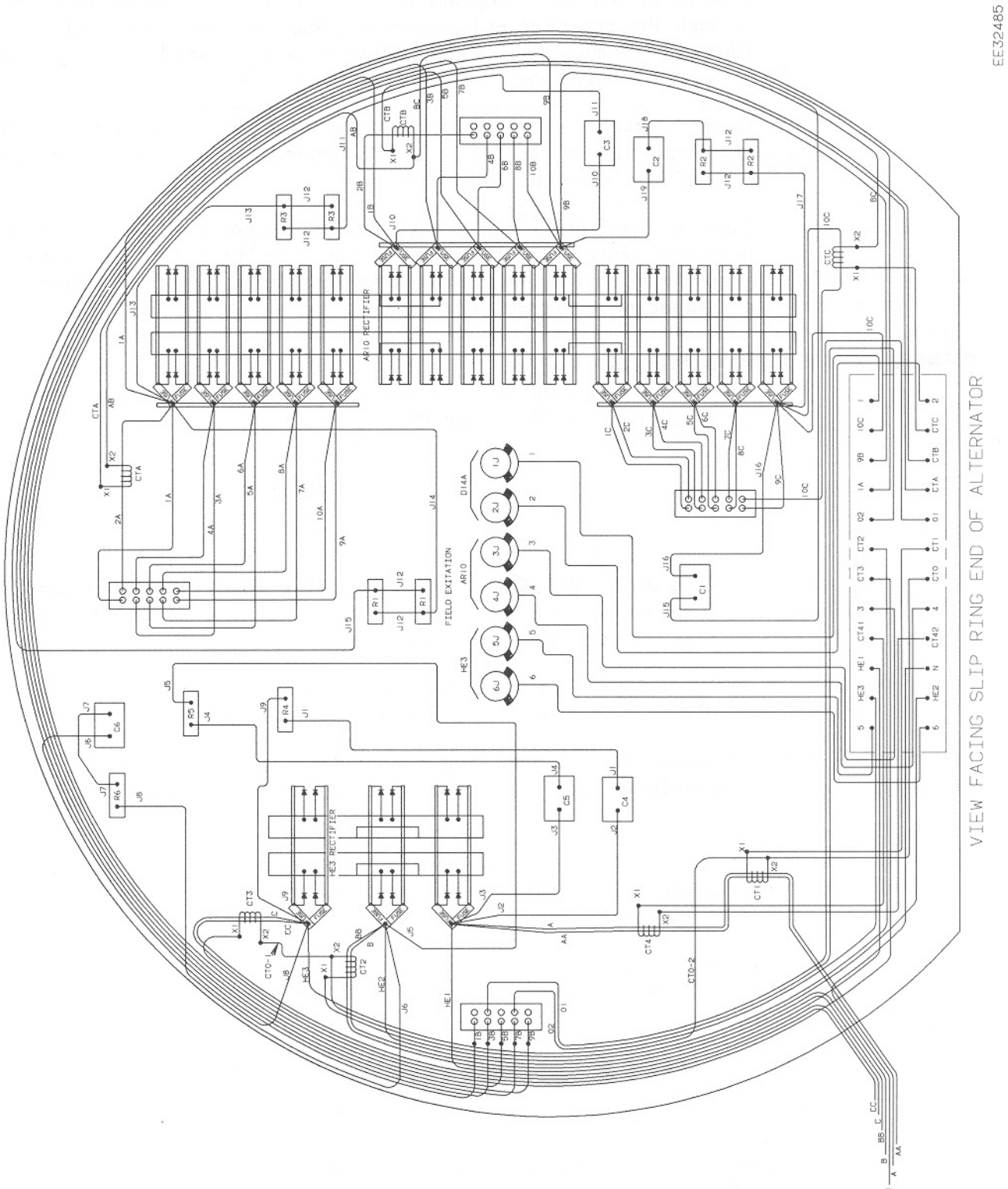


Figure 40. Typical Generator Wiring Diagram. - Model AR10JBA-HE3-D14A

SERVICE DATA

REFERENCES

D14 Alternator ..... M.I. 3306

Alignment Of Locomotive Rotating Equipment ..... M.I. 1753

SPECIFICATIONS

Table 2. COLD RESISTANCE LIMITS - in ohms at 167°F (75°C)			
AR10			
	Nominal	*Max.*	*Min.*
Rotor Collector Ring To Collector Ring	1.238	1.288	1.188
Stator Line To Neutral Per 10 Parallel Phase Groups To Either Neutral	0.00220	0.00229	0.00211
Stator Line To Line Per 10 Parallel 10 Phase Groups	0.00292	0.00304	0.00280
HE3			
Rotor Collector Ring To Collector Ring	2.31	2.35	2.27
Stator Line To Line At Fuse Studs	.04895	.0503	.0476
HE4			
Rotor Collector Ring To Collector Ring	2.31	2.35	2.27
Stator Line To Line At Fuse Studs	.205	.211	.199
HE5			
Rotor Collector Ring To Collector Ring	2.31	2.35	2.27
Stator Line To Line At Fuse Studs	.278	.286	.270

Weights

AR10 ..... 15,700 lbs(7 120 kg)
Traction Rectifier Bank ..... 100 lbs(45 kg)
HEP Rectifier Bank ..... 40lbs(18 kg)

Brushes

Number of Brushes 12
Grade 255

Brush Part Number

Used With Single Brush Holder 8413188 8413190
Used With Single Brush Holder 8413189 8413191

Brush Size

8413190 ..... (2-1/8x1-1/3x1/2)in
(54x32x13)mm
8413191 ..... (2-1/8x1-1/3x1/2)in
(54x32x13)mm
Wear Limit .....3/4in(19mm)

Brush Holder 8413188

Number 8
Spring Pressure..... (3.3 +/- .33)lb
(1.50 +/- 0.15)kg

Brush Holder 8413189

Number 4
Spring Pressure..... (3.3 +/- .33)lb
(1.50 +/- 0.15)kg

NOTE

- For D14 brushes and brush holders, see M.I. 3306

Collector Rings

Maximum Ring Eccentricity .....0.006 in (0.15 mm)
Maximum Lateral Ring Runout .....1/32 in(0.8mm)
Condemning Limit On Ring Outside Diameter .....10-3/4 in (273mm)

ROLLER BEARING

OUTER DIAMETER ..... 10.2362 in (259.999 mm)
+ 0.0000 in (+ 0.000 mm)
- 0.0014 in(- 0.036 mm)

BEARING BORE ..... 4.7244 in (120.000 mm)
+ 0.0000 in(+ 0.000 mm)
- 0.0008 in(- 0.020 mm)

		+ 0.000 in (+ 0.00 mm)
WIDTH	3.3858 in (86.000 mm)	
		- 0.005 in (- 0.13 mm)

INTERNAL CLEARANCE ..... (before assembly)	(0.0041 - 0.0059) in (0.104 - 0.150) mm
INTERNAL CLEARANCE ..... (after assembly)	0.0025 in minimum (0.064 mm minimum)

		+ 0.0040 in (+ 0.102 mm)
BEARING HOUSING BORE INSIDE DIAMETER	10.2422 in (260.152 mm)	
		- 0.0000 in (- 0.000 mm)

LUBRICANT CAPACITY

Bearing Cap	10 oz (284 g)
Bearing	13 oz (369 g)
Outer Bearing Cover	10 oz (284 g)
TOTAL	33 oz (937 g)

Coupling Disc Torque (lubricated with Texaco Threadtex)

12 Bolt Application	1350 ft-lbs (1830 N-m)
Engine To Generator Coupling Bolt Nut Torque	295 ft-lbs (400 N-m)

EQUIPMENT LIST

Pyrometer	8364533
Induction Heater	8041446
Stone (1x1-1/2x5) in - 2 required	8204167
Torque Wrench 0 - 50 ft-lbs, 1/2 drive	8375396
Special Diode Socket 1-17/64 Hex.	8361524
Joint Compound	8346481
Multimeter	8276478
Collector Ring Grinder	8219264
Collector Ring Grinder Adapter	9506268

NOTE

Two hydraulic pumps are required for bearing removal if rotor shaft has tapped hole for hydraulic bearing removal.

Hydraulic Pump 8174285
Hydraulic Pump Hose Assembly 8152395
Hydraulic Pump Oil - 1 gallon 8246430
Adapter Nipple : 1/8 in-27 8458505
Megohmmeter Tester - 1000 volt 9548311
Megohmmeter Tester, 0-200 megohms at 500 VDC 8174880
High Potential Tester 8324253,8212404
Dynamotor (MG Set),64 VDC input, 1200 VDC output 8233558
Test Leads - 12 ft (3.7 m) long 8174878
Test Leads Carrying Case 8174879
Aligning Stud : (3/4x10x8-1/4) in 8458481
Jacking Bolt (3/4x10x5) in 8458523
Generator Lifting Shackle - includes pin (2 required) 8249739
Shackle Base - 2 required
Shackle Base Bolts - 8 required 272563
Rotor Shaft Jacking Fixture ..... Work Sketch 16288
Grease Contour Mask - Bearing Cap
And Cover ..... File Drawing 919
End Housing Holding Fixture
Arbor Fixture
Collector Ring, Seals, and
Bearing Puller Assembly .....File Drawing 755
Bearing Alignment Disc ..... File Drawing 920

NOTE

File drawings and work sketches are facility drawings that are available at no charge from EMD Publications Department. These drawings include construction details for tooling that can be made by the customer.

MATERIAL LIST

Texaco Threadtex - 5 gallons (18.93 liters) 8307731
Red Air Dry Enamel (water based)
1 quart (.95 liters) 8061130
5 gallons (18.93 liters) 8084876
Molykote Lubricant paste - 1 pint (.473 liters) 9517921
Bearing Lubricant - Esso Unirex N-2
35 lbs (13.61 kg) 9507146
120 lbs (54.43 kg) 9507147

1. METRIC/ENGLISH CONVERSIONS

Table 3. METRIC/ENGLISH CONVERSIONS		
MULTIPLY:	**BY:**	**TO GET:**
LENGTH		
Microinch	0.025 4	micron (μ)
Inch	25.400	millimeter (mm)
Foot	0.304 8	meter (m)
Yard	0.914 4	m
Mile	1.609	kilometer (km)
AREA		
$Inch^2$	645.2	$millimeter^2$ (mm^2)
	6.45	$centimeter^2$ (cm^2)
$Foot^2$	0.092 9	$meter^2$ (m^2)
$Yard^2$	0.836 1	m^2
VOLUME		
Ounce	29.574	$centimeter^3$ (cm^3)
$Inch^3$	16 387.	$millimeter^3$ (mm^3)
	16.387	cm^3
	0.016 4	liter (l)
$Foot^3$	0.028 3	$meter^3$ (m^3)
$Yard^3$	0.764 6	m^3
Quart	0.946 4	liter (l)
Gallon (U.S.)	3.785 4	l
Gallon (Br. Imp.)	4.546	l
MASS		
Ounce	28.350	gram (g)
Pound	0.453 6	kilogram (kg)
Ton	907.18	kg
Ton	0.907	tonne (t)
FORCE		
Kilogram	9.807	newton (N)
Ounce	0.278	N
Pound	4.448	N

(continued, next page)

METRIC/ENGLISH CONVERSIONS		
MULTIPLY:	**BY:**	**TO GET:**
TEMPERATURE (Thermometer Reading)		
Degrees Fahrenheit – 32	0.555	degrees Celsius (C)
Degrees Celsius	1.8, then add 32	degrees Fahrenheit (F)
TEMPERATURE RISE		
Degrees Fahrenheit	0.555	degrees Celsius
Degrees Celsius	1.8	degrees Fahrenheit
ACCELERATION		
Foot/sec^2	0.304 8	meter/sec^2 (m/s^2)
Inch/sec^2	0.025 4	m/s^2
TORQUE		
Ounce-force-inch	0.007 06	newton-meter (N•m)
	0.069 2	kilogram-meter
Pound-inch	0.112 98	N•m
	0.011 52	kilogram-meter
Pound-foot	1.355 8	N•m
	0.138 25	kilogram-meter
POWER		
Horsepower	0.746	kilowatts (kW)
PRESSURE OR STRESS		
Inches of water	0.249 1	kilopascals (kPa)
Inches of mercury	3.376 85	kPa
Kilopascal	0.296 13	inches of mercury
Pounds/sq.in. (PSI)	6.895	kPa
ENERGY OR WORK		
Watt-second (W•s)	1.0	joule (J)
BTU	1 055.	J
Foot-pound	1.355 8	J
Kilowatt-hour	3 600 000.	J

(continued, next page)

METRIC/ENGLISH CONVERSIONS		
MULTIPLY:	**BY:**	**TO GET:**
LIGHT		
Foot--candle	10.764	lumens/meter^2 (lm/m^2)
FUEL PERFORMANCE		
Miles/gal. (MPG)	0.425 1	kilometers/liter (km/l)
Gallons/mile	2.352 7	liters/kilometer (l/km)
VELOCITY		
Miles/hour (MPH)	1.609 3	kilometers/hr. (km/h)

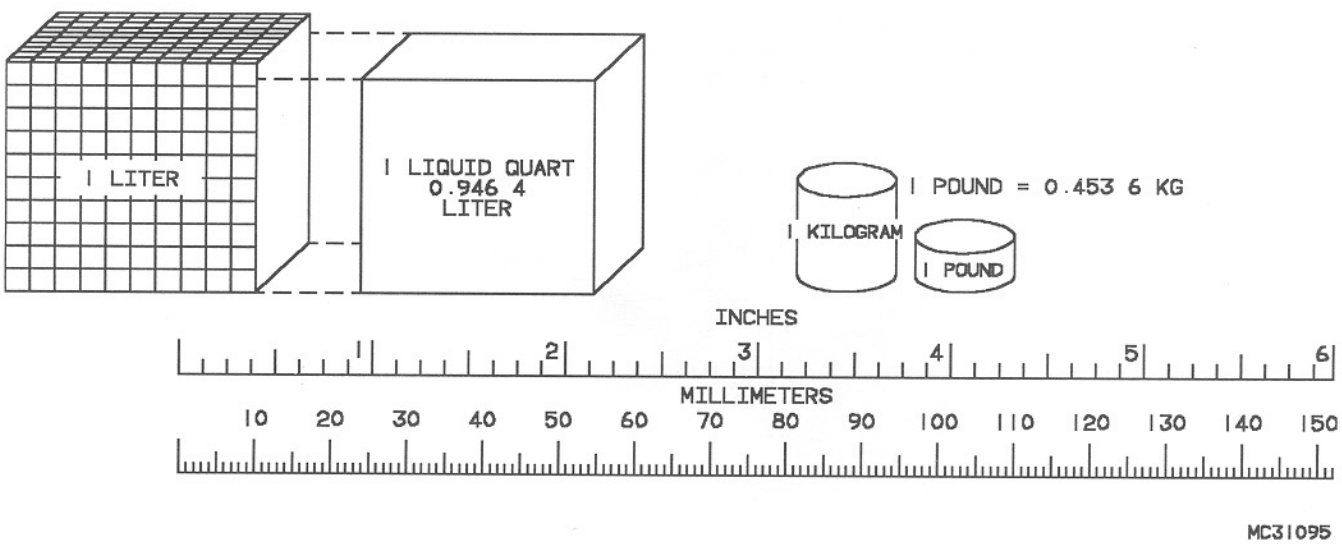


Figure 41. Graphic Comparison of Metric and U.S. Units of Measure