



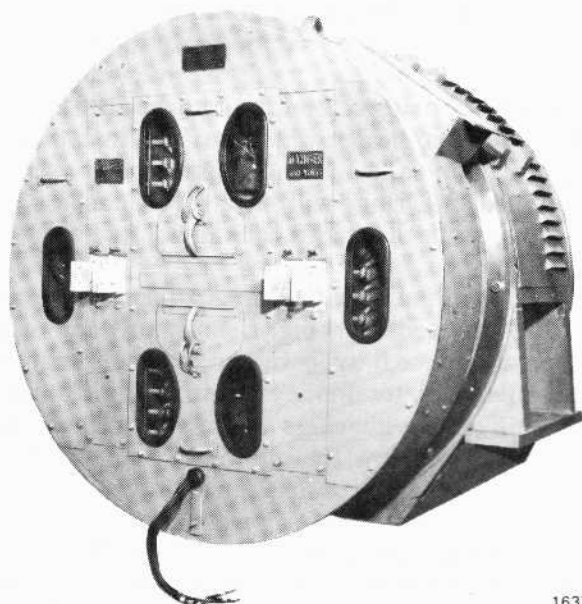
# MAINTENANCE INSTRUCTION

## AR10-D14, AR16-D14, AND AR16-D18 TRACTION GENERATORS

### DESCRIPTION

The purpose of this M.I. is to supply maintenance information for the AR10-D14, AR16-D14, and AR16-D18 traction generators. Unless otherwise specified the data is applicable to all three models. To avoid repetitive wording the AR16-D18 designation is provided in parentheses wherever it applies.

The AR10-D14, AR16-D14, and AR16-D18 traction generators, Fig. 1, are composed of two, three-phase, alternating current generators of the single bearing type.



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Fig.1 - Typical Traction Generator (AR10-D14)

The rotors of the two machines are mounted on a single shaft which is, in turn, directly connected to

the engine crankshaft through a flexible flywheel coupling. The shaft is supported at the outboard end by a single, lubricated, self-aligning bearing assembled in an end housing which is, in turn, bolted to the main frame or stator of the AR10 (AR16). The D14 (D18) stator is bolted to the opposite, or coupling end, of the (AR16) AR10 stator.

The rotating fields 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.

The AR10 (AR16) field coils are insulated with class "F" insulation, and are electrically connected to the two inboard collector rings mounted in the air box at the bearing end of the generator. The D14 (D18) field coils are electrically connected to the two outboard collector rings. The collector rings and associated brush holders provide the means of exciting the fields of the two machines.

Current production models are equipped with an air box cover which includes diode viewing windows and two access doors, Fig. 1. These doors provide easy access to the collector rings or brushes for inspection or replacement of brushes. Another feature is the collector ring cover, Fig. 2, to prevent snow from entering the collector ring area.

The AR10 (AR16) stator frame and core assembly, utilizing welded construction, provides a rigid structure which houses the stator windings and supports the end housing and D14 (D18) stator assemblies. The class "H" insulated AR10 (AR16) stator coils are internally connected at the bearing end of the stator into two sets of three-phase "Y" connected windings.

\*This bulletin is revised and supersedes previous issues of this number.

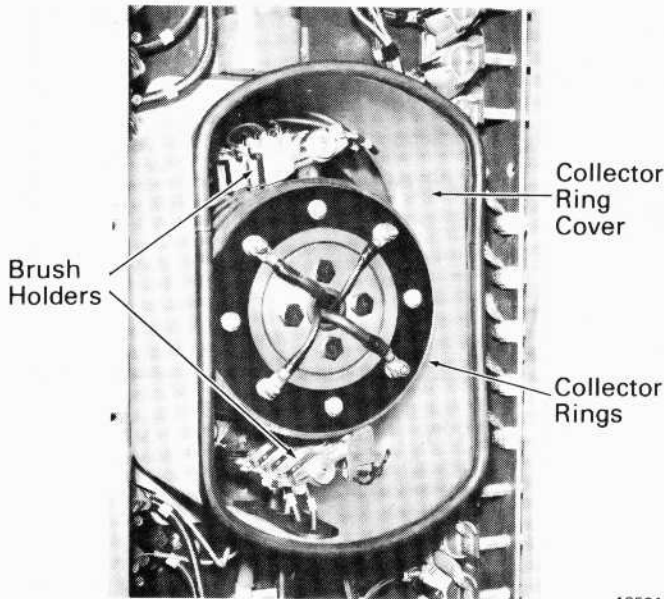


Fig.2 – Brush Holder Installation

Two rectifier assemblies mounted on the front of the AR10 (AR16) generator provide means of converting the three-phase AC power to DC power. 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.

This instruction covers only the main generator part of the AR10 or AR16 assembly. For information on the rectifier assemblies see M.I. 3317-2, and see M.I. 3306 for the D14 alternator.

## MAINTENANCE

This generator is designed and manufactured to provide a long service life and optimum performance with a minimum of maintenance. Like any machine, however, certain maintenance is required, the extent of which is largely determined by the operation and service to which the generator is subjected. 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 generator 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 generator 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.

## COLLECTOR RINGS AND BRUSHES

Collector rings, Fig. 2, should be checked frequently while generator is in operation. Any sparking should be corrected immediately. It is normal for the negative ring to experience electrical wear more rapidly than the positive ring. The unequal wear can be minimized by reversing polarity of the rings. The frequency of this reversal is provided in the applicable Scheduled Maintenance Program.

Sparking on collector rings may be due to the various causes listed below:

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

If the collector ring concentricity exceeds 0.15 mm (0.006") total indicator reading (rings installed on generator) and collector ring lateral runout exceeds 0.8 mm (1/32"), rings will have to be machined or stoned to bring them into tolerance.

A rough or pitted collector ring surface is normally due to prolonged sparking. Usually this condition can be corrected by grinding. The minimum acceptable diameter on the collector rings is 260 mm (10-1/4"). If rough rings cannot be cleaned up without going below the minimum diameter, they should be replaced.

A collector ring grinder is available (8219264) which must be mounted to the generator with an adapter. Adapter 9506268 is used on large bearing (260 mm) generators and adapter 8364940 is used on small bearing (215 mm) generators.

To provide clearance for the grinder and adapter, the collector ring cover (snow guard), the four 12 o'clock brushholders, and two diode fuses must be removed.

The adapter assembly should be mounted at the 2 o'clock position on the bearing housing flange using two of the eight 3/4-10" bearing housing to generator end housing bolts.

### CAUTION

Care must be taken to avoid damage to or loss of the insulating washers and tubes surrounding the bearing housing to end housing bolts so that electrical isolation of the bearing is maintained.

Position the grinder so there will be 3.2 mm (1/8") clearance between it and the rings to be ground. Install grinding stones in position on the grinder, making certain there will be enough travel to grind the rings.

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

### CAUTION

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

When the stones are in contact with the rings, grind until the ring surface is smooth. After grinding, check the surface with a dial indicator. Concentricity should not exceed 0.15 mm (0.006") total indicator reading.

When the grinding operation is complete, stop the engine and remove the grinding equipment. Blow out all grinding dust, and reassemble the brush holder assembly in its proper position. Replace brushes if necessary.

### CAUTION

Never use emery cloth for polishing collector rings, due to its continued abrasive action.

Current model generators are equipped with eight constant pressure brush holders, four mounted at the top of the collector ring assembly, and four at the bottom. Earlier model generators had four double arm brush holders mounted at the top of the collector ring assembly. The brushes riding on the two inside collector rings are for the AR10 (AR16) generator, and the brushes riding on the two outside collector rings are for the D14 (D18) alternator. The spring pressure is preset and cannot be adjusted. The pressure will remain constant throughout the brush life, regardless of brush wear.

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

If a brush holder is vibrating, tighten brush holder support bolt and see that brush holder is fastened securely to support.

When installing new brushes, they should be sanded to fit the curvature of the collector ring. This can be done by putting a piece of sandpaper on the surface of the ring with the rough side against the brush. Then with the brush held down with pressure arm of the brush holder, move sandpaper in direction of rotation of the rings. Repeat motion until brush fits curvature of the rings.

Make sure the coil spring rests on top of the brush and not on the holder when applying the spring clip.

## BEARING

A grease lubricated, double row, spherical, self-aligning bearing is assembled into an insulated bearing housing. The bearing housing is insulated to prevent damage from electrical arcing. Additional lubrication is not required. Occasional checks of bearing temperature during operation, by applying a pyrometer to the outside surface of the bearing cover, will give an indication of the bearing condition. The bearing temperature should not exceed a 25° C (45° F) rise. High bearing temperature may be caused by:

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

Generators manufactured after November, 1971, are equipped with a 260 mm (10.2362") bearing and generators manufactured prior to November, 1971, have a 215 mm (8.4646") bearing with a phenolic lined bearing housing. The large bearing will operate for a longer service period than the smaller bearing and will require maintenance at intervals recommended in the Scheduled Maintenance Program. The small bearing should not require maintenance, but should be replaced with a new bearing and bearing housing at intervals recommended in the Scheduled Maintenance Program.

## LARGE BEARING MAINTENANCE

The large bearing requires maintenance at intervals recommended in the Scheduled Maintenance Program. This can be accomplished either by

removing the generator from the installation and following the Generator Disassembly procedure of this instruction or by changing the bearing with the generator in place as follows:

1. Remove the two center air box covers.
2. Disconnect collector ring brush holder connections and tape out of the way.
3. Remove top and bottom brush holder studs.
4. Disconnect field leads from collector ring studs, Fig. 3.
5. Remove the four bolts securing the retainer plate, Fig. 3, 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 Drawing listed in Service Data.

6. Remove the four 3/8"-16 bolts securing the collector rings to the collector ring housing. They are located in the collector ring face between the lead connection terminals. Place extension cup around field leads and bolt extension cup to shaft as shown in Fig. 4.

7. Install puller plate and puller studs to remove collector ring assembly, as shown in Fig. 4. Place hydraulic jack between extension cup and puller plate, supported by cradle studs of puller plate. Remove collector ring assembly using hydraulic jack.
8. Remove puller studs from collector ring assembly and install original bolts. Torque bolts to 9.5 to 12.2 N·m (7 to 9 ft-lbs).
9. Install puller plate and puller studs to remove outer seal, as shown in Fig. 4. Place hydraulic jack between extension cup and puller plate, supported by cradle studs of the puller plate. Remove outer seal using hydraulic jack. Remove hydraulic jack, puller plate, and puller studs.
10. Remove bolts from bearing cover, Fig. 4, and remove bearing cover.
11. 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.

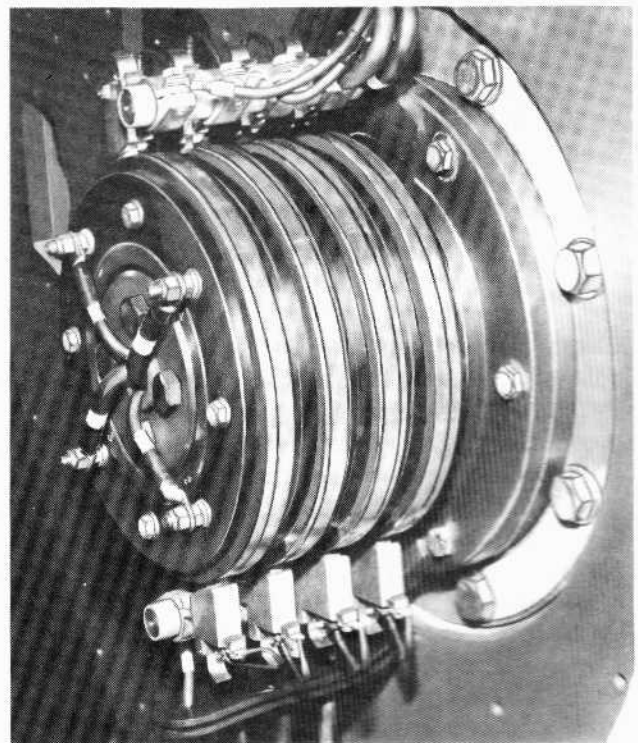
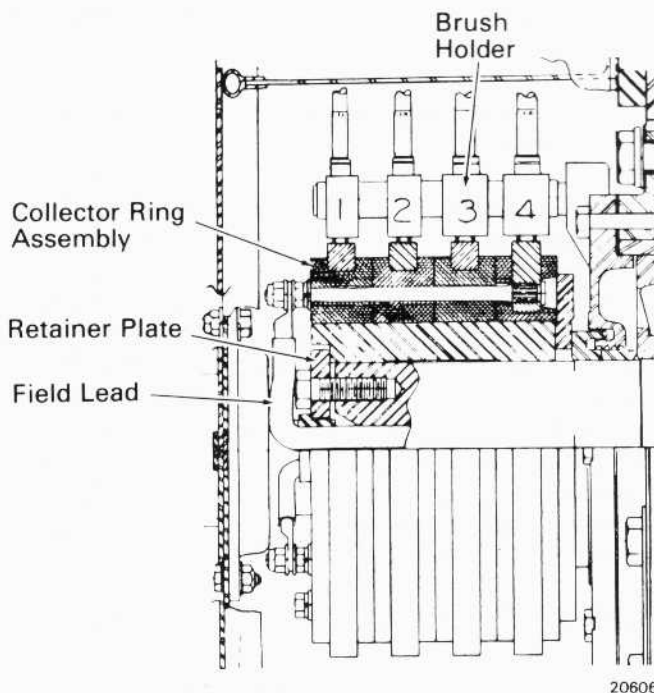


Fig.3 - Collector Ring Assembly (AR10)

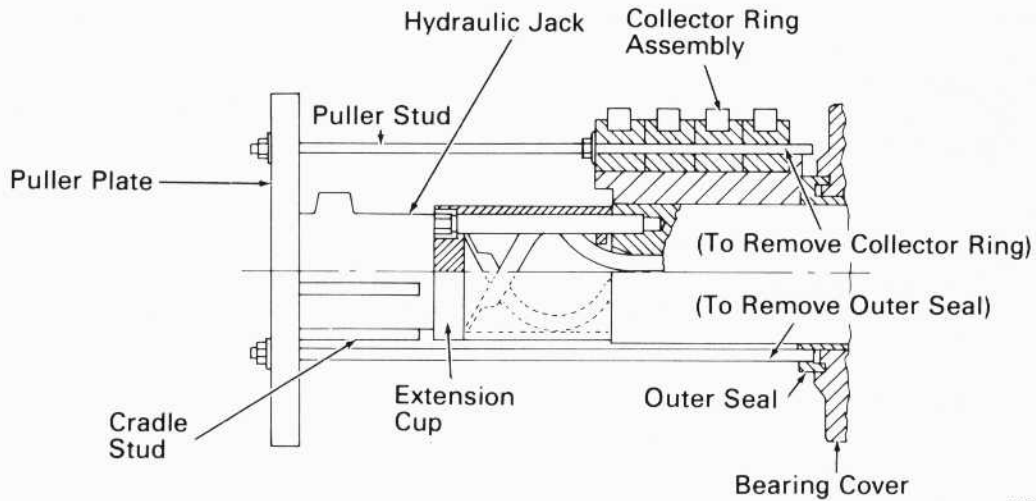


Fig.4 – Collector Ring And Outer Bearing Seal Removal

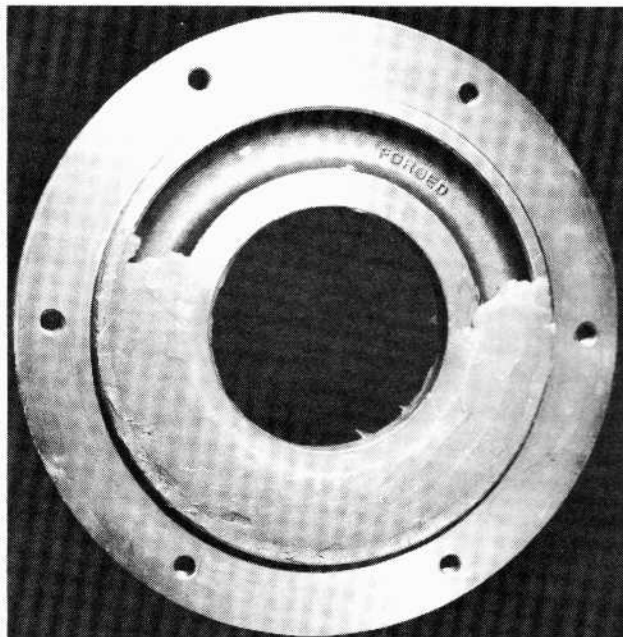
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12. If no distress is found, thoroughly clean the bearing cover.
13. Fill the labyrinth grooves in the bearing cover with Esso Unirex N-2 grease. This grease need not be measured.
14. Weigh the piece of paper that will be used in handling the grease to fill the groove in bearing cover. The weight of the paper must be compensated for when weighing the grease.
15. Carefully weigh the Esso Unirex N-2 grease for the bearing cover groove. Refer to Service Data for proper quantity.

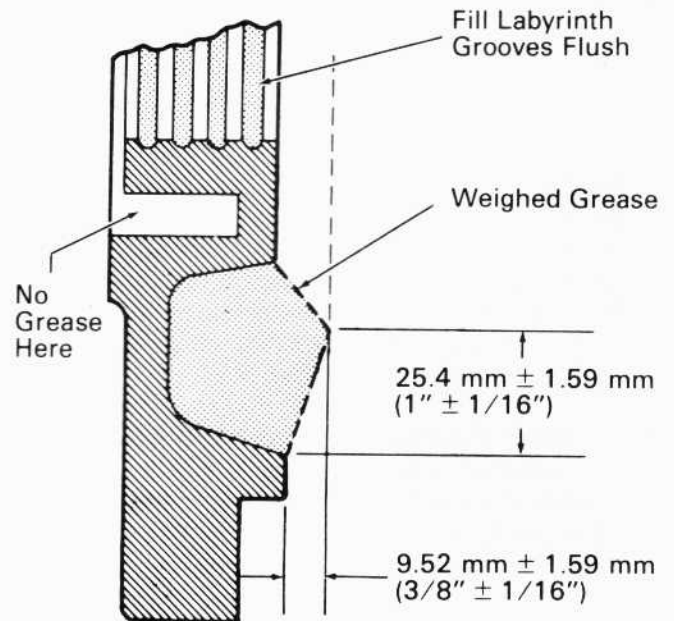
**NOTE**

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

16. 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 Fig. 5.
17. 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



18929



Large Bearing Cap Or Cover

20608

Fig.5 – Application Of Grease To Large Bearing Cover And Bearing Cap

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. Esso Unirex N-2 grease can be added to the grease (Cyprina RA) already in the bearing.

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

**CAUTION**

In Step 19, do not allow seal to be heated above 105° C (220° F). Overheating may result in warping or damaging the metal.

19. Heat the outer seal in an oil bath, electric oven, or induction heater for half an hour at 105° C (220° F). 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.
20. Place collector ring on induction heater and heat to 105° C (220° F). 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.
21. Place retainer plate over leads and on to the end of the rotor shaft. Tighten 5/8"-11 bolts to 135.5 to 149 N·m (100-110 ft-lbs).

**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 4 on the steel housing adjacent to the terminals are connected to the appropriate collector rings (No. 1 outboard, No. 4 inboard).

22. Connect the large leads from the AR10 (AR16) to collector ring terminals 3 and 4, and the smaller leads from the D14 to terminals 1 and 2. Torque to 9.5 to 12.2 N·m (7 to 9 ft-lbs).

**NOTE**

Generators having the 215 mm (8.4646") bearing with the phenolic housing do not require bearing maintenance, but are to be replaced with a new bearing at intervals

recommended in the Scheduled Maintenance Program.

**SMALL BEARING CHANGEOUT**

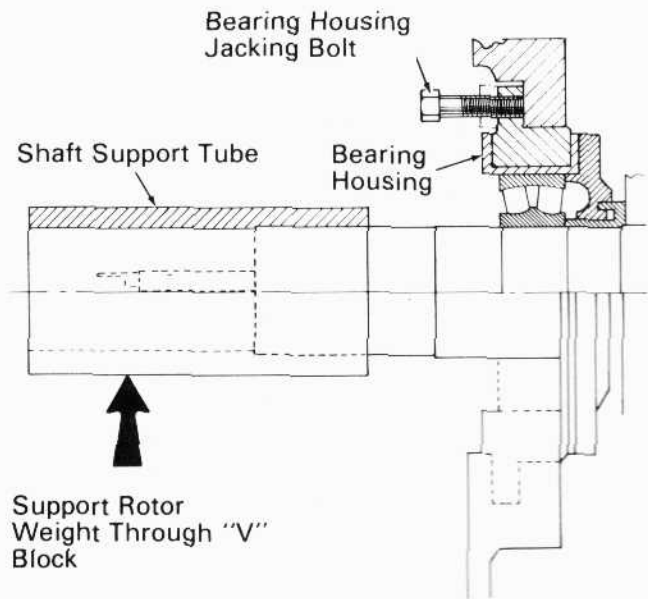
The small bearing with the phenolic housing should be replaced with a new bearing at intervals recommended in the Scheduled Maintenance Program. This can be accomplished either by removing the generator from the installation and following the Generator Disassembly procedure of this instruction or by changing the bearing with the generator in place as follows:

**BEARING REMOVAL**

**NOTE**

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

1. Perform Steps 1 through 8 of Large Bearing Maintenance procedure.
2. Install shaft support tube as shown in Fig. 6. Support shaft through a "V" block with an adjustable jack.



20609

Fig.6 - Bearing Housing Removal

3. Remove bearing housing bolts and remove bearing housing by using special 3/4"-10 jacking bolts, threaded full length, in the jacking holes provided in the housing as shown in Fig. 6.

**NOTE**

Some early generator bearing housings had 5/8"-18 jacking holes. Ensure proper bolts are used.

4. 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.
5. Install rotor shaft jacking fixture as shown in Fig. 7. Raise rotor until bearing is approximately centered in the bore of the housing.

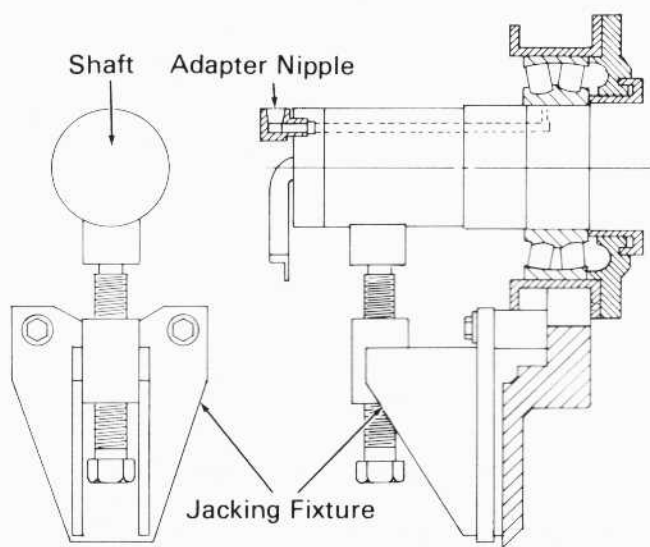


Fig. 7 - Rotor Shaft Jacking Fixture

6. If rotor shaft has a tapped hole in the end of the shaft for hydraulic bearing removal, 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, Fig. 7, into tapped hole in shaft and tighten.
  - c. Connect hydraulic pump, Fig. 8, to adapter nipple.
7. If shaft is not equipped for hydraulic bearing removal, it is necessary to protect the stator and rotor windings and remove the outer race and cage with a cutting torch.



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Fig. 8 - Hydraulic Pump

8. Thread six puller studs into flange of bearing cap. Install six spacer tubes and centering ring as shown in Fig. 9.

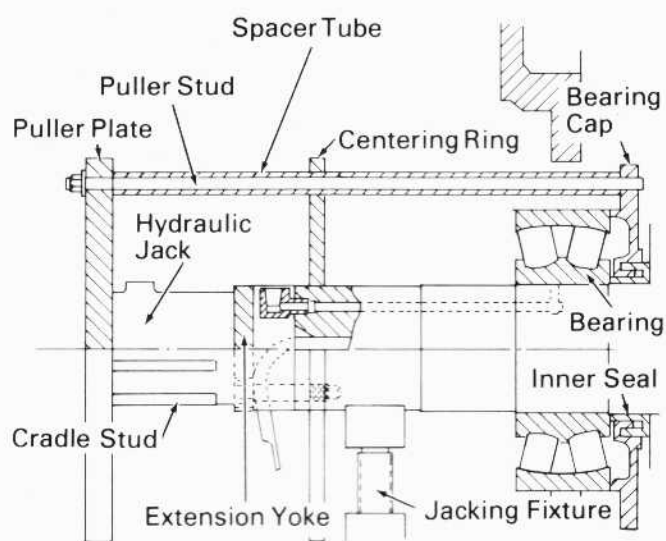


Fig. 9 - Bearing Removal

9. Place extension yoke around field leads and bolt extension yoke to shaft as shown in Fig. 9.
10. Install puller plate. Place hydraulic jack between extension yoke and puller plate, supported by cradle studs of puller plate as shown in Fig. 9.
11. If rotor shaft is equipped for hydraulic bearing removal, pump up hydraulic jack to expand inner bearing race with hydraulic pressure.

Maintain this pressure and operate the removal jack until the bearing slides off the shaft seat (approximately 63.5 mm [2-1/2"]).

12. If rotor shaft is not equipped for hydraulic bearing removal, heat the bearing inner race with a heating torch and remove with the puller studs.
13. 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.
14. 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

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

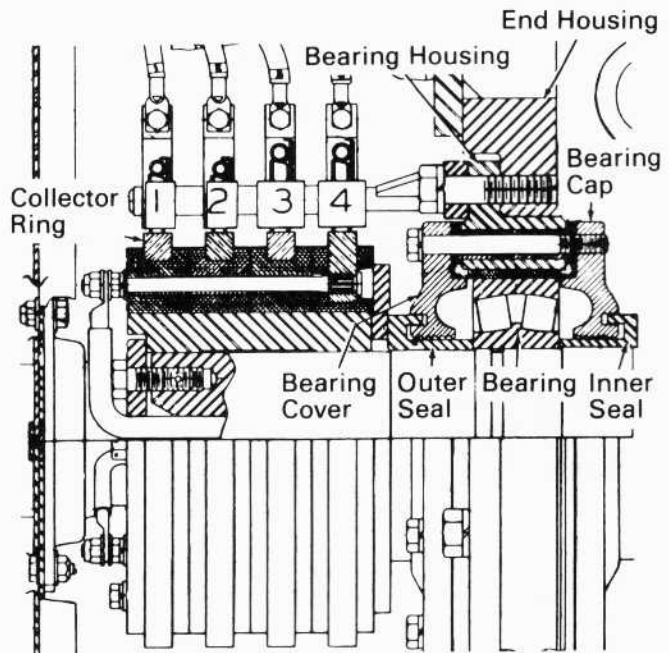
Before shrinking bearing to rotor shaft, it is very important to try the bearing in the housing. Place bearing housing on the floor and slide bearing through the bore of the housing. Ensure bearing enters bearing housing squarely, and is not cocked. Refer to Service Data for bearing dimensions and tolerances.

Use the following procedure to assemble bearing. Refer to Fig. 10 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 105° C (220° F). 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.



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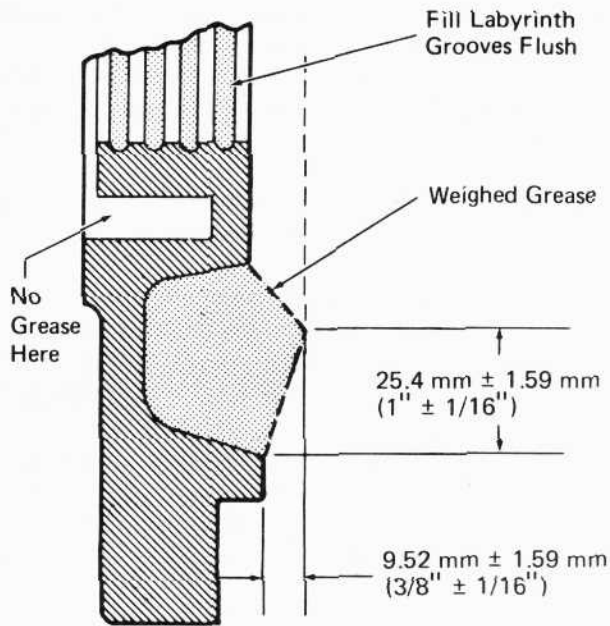
Fig.10 - Bearing And Collector Ring Assembly Cross-Section

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 Fig. 5, to limit churning and liquefaction of the grease. Form grease to proper contour as shown in Fig. 11.
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 completely with grease.



Large Bearing Cap Or Cover

20608

Fig. 11 - Contour Of Grease In Bearing Cover And Bearing Cap

8. Heat roller bearing with an induction heater to 105° C (220° F). 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.

Apply Molykote spray (9316707) or Molykote paste (9517921) to inside diameter of bearing housing. The spray must be allowed to dry but, if the paste is used, the housing can be assembled to the bearing immediately.

10. Thread two 3/4"-10 jacking bolts into top two holes in end housing. Thread full length as shown in Fig. 6.
11. Install shaft support tube and supporting jack as shown in Fig. 6. Raise rotor until bearing is accurately centered in bore of end housing.
12. Align bearing cap to bearing housing and bearing housing to end housing using the two 3/4" jacking bolts. Carefully pull bearing housing over bearing and into end housing bore. Replace jacking bolts with standard end

housing bolts when the bearing housing is partially engaged. Tighten individual bearing housing bolts only a partial turn before proceeding to the next bolts only a partial turn before proceeding to the next bolt in a 12, 6, 3, and then 9 o'clock rotation. This is to prevent wedging of the bearing housing in the end housing or of the outer race in the bearing housing. Check frequently during this operation to ensure that outer race has not tilted in the bearing housing. Continue tightening until the bearing housing flange seats against the end housing, then torque end housing bolts to 271 N·m (200 ft-lbs).

13. Carefully weigh the Esso Unirex N-2 grease for the bearing cover groove. Refer to Service Data for proper quantity.
14. 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. 11.
15. Install greased bearing cover and a new gasket onto shaft. Tighten mounting bolts to 68 to 75 N·m (50 to 55 ft-lbs).
16. Heat outer seal in an oil bath, electric oven, or induction heater for half an hour at 105° C (220° F). If an oil bath is used for heating, remove oil from outer 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 let it cool to room temperature.
17. Place collector ring on induction heater and heat to 105° C (220° F). Pyrometer readings (with current off) should be taken periodically. After heating, place collector ring against outer seal. Rotate ring assembly for proper position of lead connections to terminals of ring assembly.
18. Place retainer plate over leads and on to end of rotor shaft. Ensure cable grommet is in retainer plate hole. Tighten 5/8"-11 bolts to 135.5 to 149 N·m (100 to 110 ft-lbs).
19. Connect the large leads from AR10 (AR16) to collector ring terminals 3 and 4, and the smaller leads from the D14 (D18) to terminals 1 and 2. Torque bolts to 9.5 to 12.2 N·m (7 to 9 ft-lbs).

20. Mount brush holders. Adjust or replace brushes as necessary. Connect leads. Install snow guard, if used. Install air box covers.

**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, re-align generator per M.I. 1753 and follow reassembly and end play remarking procedure of this Maintenance Instruction.

**GENERATOR DISASSEMBLY**

**NOTE**

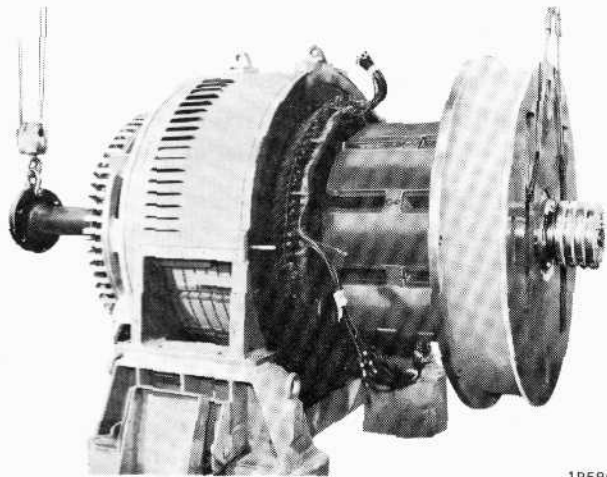
If equipment for disassembly and assembly is not available, generator should be returned to the Electro-Motive Division for repair either on a rebuild and return, or unit exchange basis.

Before the generator is removed from its location, place strips of fish paper 1.6 mm x 76 mm 914 mm (1/16" x 3" x 36") 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.

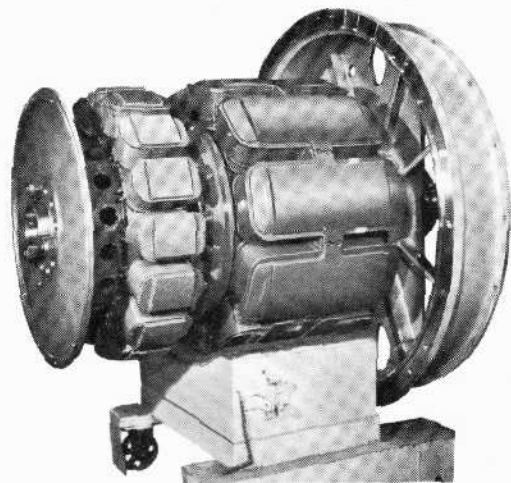
1. Mount the generator on a sturdy stand at a suitable height from the floor.
2. Remove all covers from the generator assembly.
3. Disconnect leads to brush holder and filter assemblies.
4. Remove bolts holding air box to end housing, and remove air box carefully.
5. Remove collector ring cover, brush holders and brush holder bracket assembly.
6. Remove rectifier bank assemblies from end housing assembly.
7. Remove cleat assemblies securing stator leads to end housing.
8. Support end housing with a wire cable and a crane and remove bolts securing end housing to stator.

9. Insert three 3/4"-10 jack bolts equally spaced around the end housing in the bolt holes from which the end housing to stator bolts were removed. Turn jack bolts until end housing is separated from stator.
10. Apply arbor fixture to spider bore of rotor, and attach a wire cable to arbor fixture.
11. With the aid of a crane, raise the arbor fixture until the air gap is equal around the circumference of the rotor. With the aid of a second crane, raise the front end until the cable is taut.
12. Carefully remove the rotor assembly from the stator, Fig. 12, moving it towards the front end of the assembly until it clears the stator assembly, and can be rested on a stand, Fig. 13.



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Fig.12 - Removing Rotor From Stator



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Fig.13 - Rotor Assembly Removed From Stator

13. If necessary, the coupling disc and D14 (D18) rotor can be removed from the AR10 (AR16) rotor.

## 14. Disconnect leads from collector ring.

**NOTE**

The AR16 current collector bus assembly, shown in Fig. 14, is made of solid copper straps instead of cables. The increased copper cross-section is required to carry the added current.

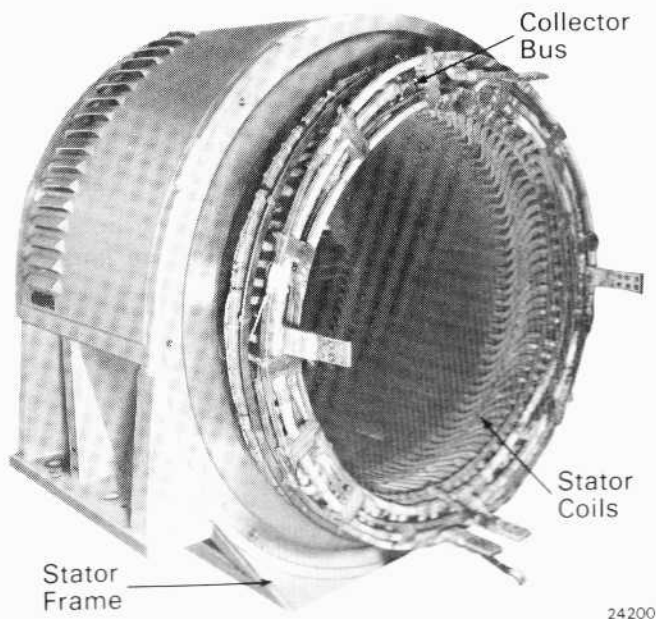


Fig.14 - AR16 - Collector Bus Assembly

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

**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 Drawings listed in Service Data.

## 16. Remove four 3/8"-16 bolts securing the collector ring to the collector ring housing, which are located in the collector ring face between the lead connection terminals. Place extension cup around field leads and bolt extension cup to shaft as shown in Fig. 4.

## 17. Install puller plate and puller studs to remove collector ring assembly, as shown in Fig. 4. Place hydraulic jack between extension cup and puller plate, supported by cradle studs of puller plate. Remove collector ring assembly using hydraulic jack.

## 18. Remove puller studs from collector ring assembly and install original bolts. Torque bolts to 9.5 to 12.2 N-m (7 to 9 ft-lbs).

## 19. Install puller plate and puller studs to remove outer seal, as shown in Fig. 4. Place hydraulic jack between extension cup and puller plate, supported by cradle studs of puller plate. Remove outer seal using hydraulic jack. Remove hydraulic jack, puller plate, and puller studs.

## 20. Remove bolts from housing cover, Fig. 4, and remove bearing cover.

## 21. Remove bearing housing from end housing, Fig. 4.

**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. If rotor shaft has a tapped hole in the end of the shaft for hydraulic bearing removal, 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, Fig. 7, into tapped hole in shaft and tighten.
- c. Connect hydraulic pump, Fig. 8, to adapter nipple.

## 23. If shaft is not equipped for hydraulic bearing removal, it is necessary to protect the stator and rotor windings and remove the outer bearing race and cage with a cutting torch.

## 24. Thread six puller studs into flange of bearing cap. Install six spacer tubes and centering ring as shown in Fig. 9.

## 25. Place extension yoke around field leads and bolt extension yoke to shaft as shown in Fig. 9.

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

## 27. If rotor shaft is equipped for hydraulic bearing removal, pump up hydraulic jack to expand inner bearing race with hydraulic pressure.

Maintain this pressure and operate the removal jack until the bearing slides off the shaft seat (approximately 63.5 mm [2-1/2"]).

28. Remove bearing inner seal using small heating torch and pry bars.
29. Remove D14 (D18) stator closure assembly, if necessary.
30. Ensure the D14 (D18) stator assembly is properly supported and remove bolts securing the D14 (D18) stator assembly to the AR10 (AR16) stator assembly. Install 3/4"-10 jack bolts and remove the D14 (D18) stator assembly.

## ELECTRICAL INSULATION TEST

Before the generator is assembled, it is advisable to electrically qualify the stator, Fig. 15, 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.

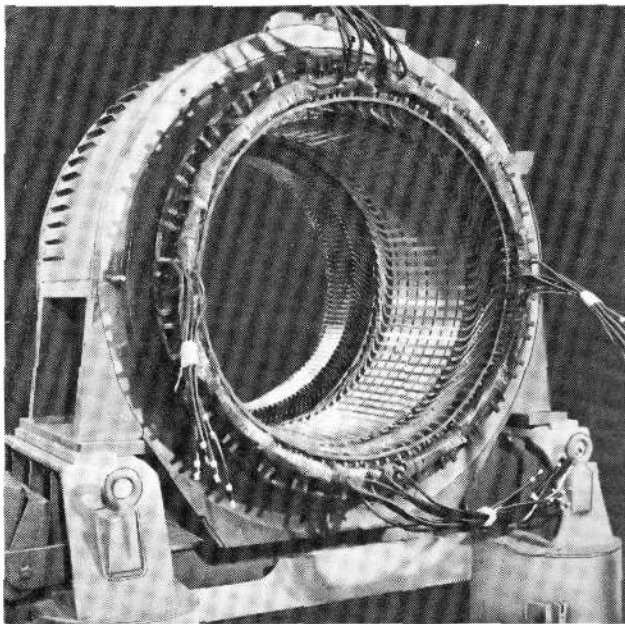


Fig.15 - Typical Stator (AR10)

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 75° C to 90° C (167° F to 194° F).

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 50° C (122° F).
4. The insulation resistance of the rotor must be not less than one megohm at any temperature up to 75° C (167° F).

Any stator or rotor which, although clean, shows low or erratic insulation resistance readings, should be dried at 90° C (194° F) 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

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

1. For stators, short all positive and negative bus bars. **DO NOT PERFORM HIGH POTENTIAL TESTS BEFORE CONSULTING M.I. 3317-2.**
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.

## BEARING INSPECTION

The roller bearing should be thoroughly inspected for possible evidence of impending failure. If the bearing shows signs of distress, it should be replaced with a new bearing. The following procedure is helpful in inspecting bearings.

## CLEANING

Before attempting to make any inspection, a bearing must be thoroughly cleaned. Stoddards solvent or

similar noncorrosive solvent having a flash point of 46° C (115° F) or higher may be used. After inspection, bearings should be dipped in hot oil to prevent corrosion, unless they are to be used immediately. A good grade of bearing oil should be used, or grease that is used for its lubrication in service.

## 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 on the unloaded side. Do not roll a feeler through a bearing. For limits, see Service Data.

## FATIGUE FAILURE

Signs of bearing fatigue 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 signs 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.

## DENTS

Dents are caused by hard particles of foreign matter being rolled between the races and rollers, causing slight depressions where the bearing surfaces have been permanently deformed. They are distinguished from fatigue failures by their smooth surface with a slightly raised edge around the dent.

Small dents in themselves cause little damage and are usually evident on the bearings which have been run. However, should the bearing show signs of more than normal distress, and should there be any question as to whether they are dents or fatigue failures, or should there be any doubt as to their effect on the life of the bearing, the bearing should be replaced.

## SCRATCHES

In general, scratches due to mishandling are not serious provided they are small.

Scratches on the bearing surface, parallel to the length of the bearing are more serious than those at an angle. Sometimes scratches are difficult to differentiate from cracks and, for this reason, if there is any doubt as to their character, they should be treated as cracks due to fatigue failure.

## HEAT

Any bearing showing evidence of having been overheated should be replaced.

## CAGES

Bearing cages which show excessive wear should be replaced.

## GENERATOR ASSEMBLY

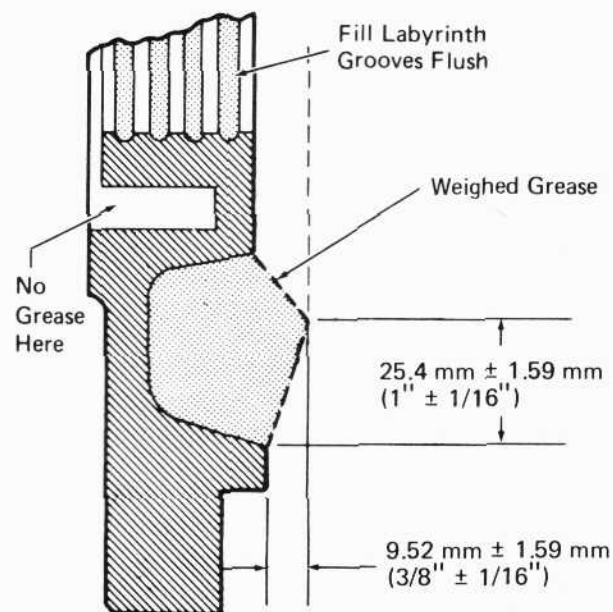
After the generator stator and rotor have been cleaned and checked, the inside of the stator and the outside of the rotor should be painted with red air drying enamel.

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.

## BEARING AND END HOUSING ASSEMBLY

1. Apply grease as specified in the Service Data to clean bearing cap and cover. See Fig. 16.



Large Bearing Cap Or Cover

20608

Fig.16 - Application Of Grease To Bearing Cover And Bearing Cap

2. 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.

3. Heat the inner seal in an oil bath, electric oven, or induction heater for half an hour at 105° C (220° F). 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 (with current off) should be taken periodically. After heating, shrink the seal to the shaft and let it cool to room temperature.
4. Install bearing cap with gasket onto shaft. The bearing cap can be distinguished from the bearing cover by noting that the cap has tapped holes in the flange while the cover has through holes which are not tapped.
5. Pack the bearing rollers and the space between the two rows of rollers completely with the quantity and type of grease specified in Service Data. On large bearings, fill groove in outer race with additional grease.

### NOTE

Esso Unirex N-2 bearing grease can be added to the grease (Shell Cyprina) already present in the bearing.

6. Heat roller bearing with an induction heater to 105° C (220° F). Take pyrometer readings (with current off) at outside face of inner race only. Also see Caution before Step 3. 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.
7. Place end housing in a horizontal position with mounting flange down, and install two guide pins 180° apart into two of the eight tapped bearing housing bolt holes. These guide pins are required to prevent damage to the outside of the bearing housing as the housing is assembled to the end housing.

8. On generators equipped with the large bearing, position insulation ring over the guide pins so holes in ring line up with holes in end housing.

9. Apply Molykote to inside diameter of bearing housing prior to assembling housing to bearing. If Molykote spray (9316707) is used it must be allowed to dry but Molykote paste (9517921) will allow immediate assembly.

10. On large bearing application, position bearing housing so bearing cover studs will be in top and bottom position.

11. Carefully lower bearing housing into position guided by guide pins. Gently tap bearing housing into position until bearing housing bottoms on end housing. Remove guide pins.

### NOTE

Steps 12 through 14 are applicable only to generators equipped with the large bearing. Refer to Fig. 17.

12. Install eight insulation tubes into bearing housing bolts holes.

13. Position outer insulation ring or insulating sections over bearing housing flange and line up holes in ring with holes in bearing housing.

14. Position four straps over insulation ring so holes in straps line up with holes in ring.

15. Install eight bolts and washers, and tighten bolts to 271 N·m (200 ft-lbs).

16. On generators equipped with the large bearing, check insulation resistance between bearing housing and end housing, using a 1000 volt megohmmeter. Reading must be 1 megohm minimum.

17. Insert two studs, Fig. 18, 180° apart in the 1/2"-13 UNC-2B threaded holes in the bearing cap. Purpose of the studs is to guide the bearing housing to the bearing cap. A bearing alignment disc, Fig. 18, may also be used in installing the end housing.

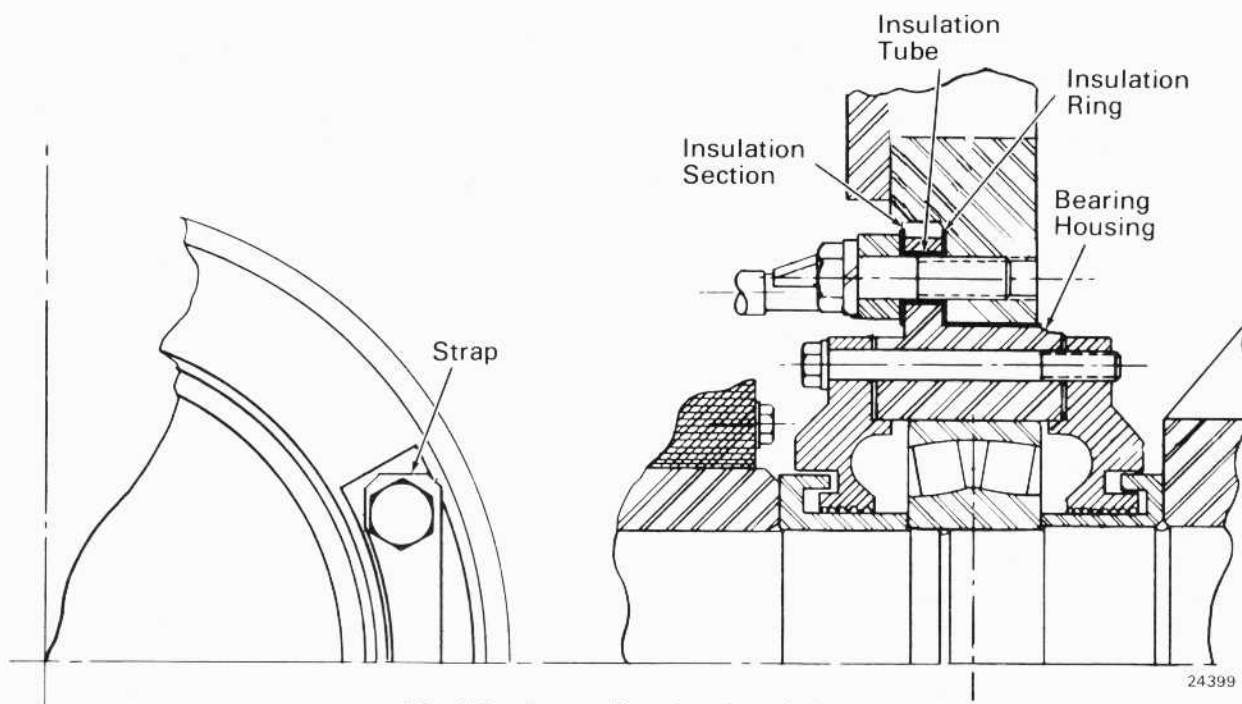


Fig.17 - Large Bearing Insulation

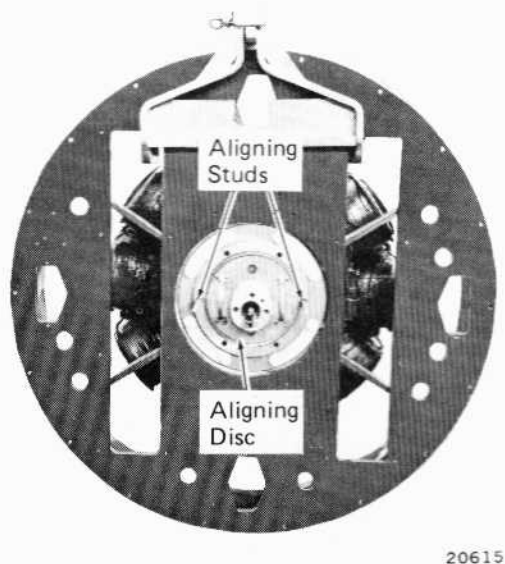


Fig.18 - Applying End Housing To Rotor Assembly

**NOTE**

Bearing alignment disc may be fabricated as detailed in Work Sketch Drawing listed in Service Data.

18. Lift the end housing and bearing housing assembly with a wire cable and crane and align the bearing housing with the aligning studs, Fig. 18. Push the end housing onto the shaft until the bearing housing is snug against the bearing cap.

19. Apply a new gasket to the bearing cover, mount the bearing cover to bearing housing, and install 1/2"-13 bolts hand tight. Do not remove the two guide studs until all the other bolts have been started. Then the guide studs can be removed, and the two bolts put in place and torqued to 68 to 75 N·m (50 to 55 ft-lbs).
20. Heat the outer seal in an oil bath, electric oven, or induction heater for half an hour at 105° C (220° F). If an oil bath is used for heating, remove oil from seal with clean, bound-edge cloths prior to shrinking to 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.

**CAUTION**

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

21. Place collector ring on induction heater and heat to 105° C (220° F). 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.

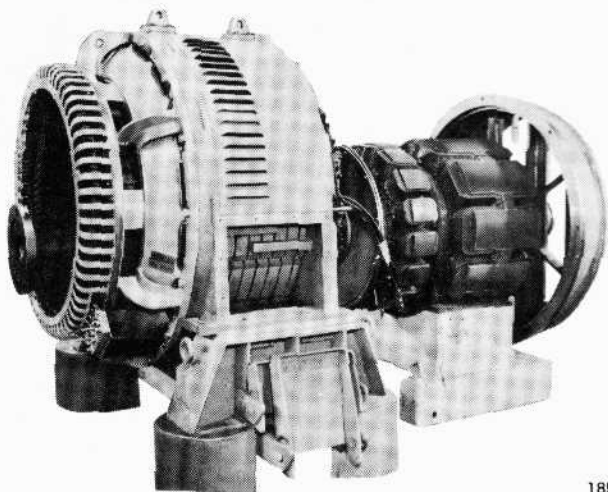
**WARNING**

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

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

**ROTOR TO STATOR ASSEMBLY**

- If the D14 (D18) rotor assembly was removed from the AR10 (AR16) rotor, bolt these two assemblies together using the 7/8"-9 bolts removed during disassembly. Be sure the D14 (D18) cable leads are threaded through the AR10 (AR16) shaft. Tighten bolts to 508 to 542 N·m (375 to 400 ft-lbs).
- Bolt D14 (D18) stator assembly to AR10 (AR16) stator frame. Torque to 271 N·m (200 ft-lbs).
- Place stator assembly and rotor assembly on their stands close enough to each other so that, when the arbor fixture is placed in the flange bore of the D14 (D18) rotor, the end of the arbor fixture protrudes through the stator assembly as shown in Fig. 19.



18588

Fig.19 - Installing Rotor In Stator

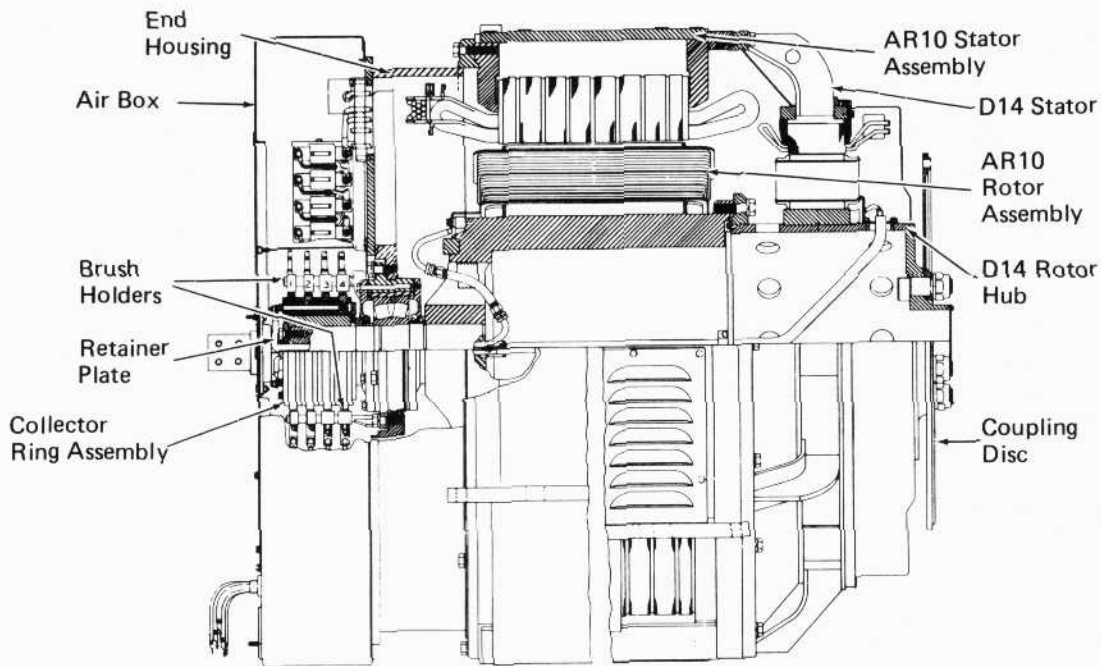
- Using two wire cable loops, place one loop through the end housing and the other loop around the arbor fixture. With the aid of two cranes, lift and guide the rotor assembly into the stator assembly slowly and carefully so the

insulation will not be damaged. When the end housing is flush against the stator frame, install the 3/4"-10 bolts to hold the end housing to the stator frame, and torque to 271 N·m (200 ft-lbs).

- Place fish paper strips 1.6 mm x 76 mm x 914 mm (1/16" x 3" x 36") in air gap between rotor assembly and coils of AR10 (AR16) alternator only. Remove wire cable loops and arbor fixture after fish paper has been applied.
- Apply coupling disc to D14 (D18) rotor hub, Fig. 20, using the bolts removed at disassembly. Torque to value specified in Service Data.
- Mount applicable brush holder bracket to bearing housing.
- Install the stator lead cleat assemblies, rectifier bank assemblies, and collector ring cover to the front face of the end housing.
- Connect the leads to the collector ring assembly, and through the collector ring cover and cable cleats to the rectifier bank assemblies.
- Mount the air box assembly to the end housing using 1/2"-13 bolts.
- Connect brush holder leads and any remaining leads that have not been connected.
- Install all covers that were removed during disassembly.
- After assembly, check to ensure that the total end movement of the bearing outer race in the bearing housing is within 9.5 mm  $\pm$  0.4 mm (3/8"  $\pm$  1/64"). If the original parts are reused, this figure may be the same as the original figure which was stamped on the face of the end housing. If the figure is not the same, blot out the original figure and stamp the new figure adjacent to it.

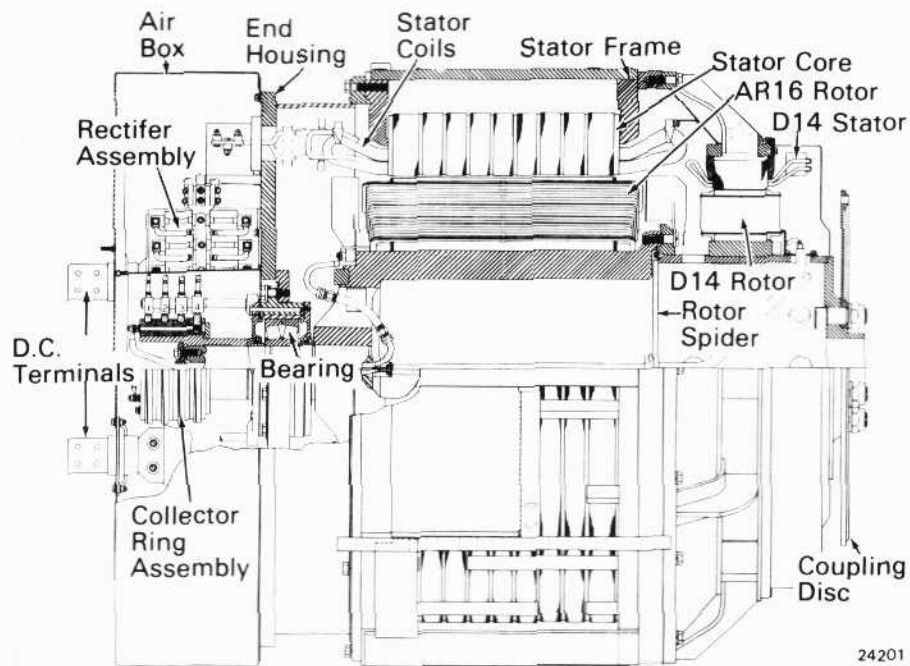
**NOTE**

A few of the earlier generators had a total end movement less than the 9.5 mm  $\pm$  0.4 mm (3/8"  $\pm$  1/64"), which can be verified by the figure stamped on the end housing.



18589

Fig.20A - AR10-D14 Generator Cross-Section



24201

Fig.20B - AR16-D14 (D18) Generator Cross-Section

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 face surface of the collector ring assembly. (On small bearing applications this dimension should be taken from the machined surface of the bearing housing between the mounting bolts instead of the bearing housing bolt head.) Stamp this measurement (approximately 8" on large bearing applications and 8-27/32" on small bearing applications and 8-27/32" on small bearing applications) to the nearest 1/64" on the end housing next to the end movement figure.

## 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 the special tooling and facilities required to make repairs.

## 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 megohmmeter. A megohmmeter reading of 1 megohm, when tested with a 1000 V 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 on 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 high voltage 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 overstressing 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 main generator and alternator 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 white lead 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 engine room. 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 its coupling fits into the beveled groove in the engine coupling disc.

Check all coupling bolts to see that they are smooth and clean. Place a little oil with white lead 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 (8307731) as a lubricant on the bolts and washers.



|   |   |  |
|---|---|--|
| Internal Clearance<br>(before assembly) | 0.104 mm to 0.150 mm<br>(0.0041" to 0.0059")                                      | 0.114 mm to 0.155 mm<br>(0.0045" to 0.0061")                                     |
| Internal Clearance<br>(after assembly)  | 0.063 mm min.<br>(0.0025" min.)   | 0.08 mm min.<br>(0.003" min.)  |
| Bearing Housing Bore Inside Diameter    | 260.152 mm $+0.102$ mm<br>$-0.000$ mm<br><br>(10.2422" $+0.0040$ "<br>$-0.0000$ " | 215.151 mm $+0.025$ mm<br>$-0.000$ mm<br><br>(8.4705" $+0.0010$ "<br>$-0.0000$ " |
| Lubricant Capacity                      |   |  |
| Bearing Cap                             | 284 g (10 ozs.)   | 170 g (6 ozs.)   |
| Bearing                                 | 369 g (13 ozs.)   | 113 g (4 ozs.)   |
| Outer bearing cover                     | 284 g (10 ozs.)   | 170 g (6 ozs.)   |
|   | Total 937 g (33 ozs.)   | 453 g (16 ozs.)  |

## Generator resistances in ohms @ 75° C

| Generator Model                                      | AR10    |         |         | AR16     |          |          |
|--|---------|---------|---------|----------|----------|----------|
|  | Nom.    | +4%     | -4%     | Nom.     | +4%      | -4%      |
| Rotor, slip-ring to slip-ring                        | 1.238   | 1.288   | 1.188   | 1.635    | 1.701    | 1.570    |
|  | Nom.    | +2%     | -2%     | Nom.     | +2%      | -2%      |
| Stator, line to neutral, per 5 phase group           | 0.00308 | 0.00314 | 0.00302 | 0.001553 | 0.001584 | 0.001522 |
| Line to line per 5 phase group                       | 0.00568 | 0.00579 | 0.00557 | 0.002729 | 0.002784 | 0.002674 |
|  | Nom.    | +8%     | -8%     | Nom.     | +8%      | -8%      |
| Stator line to neutral per paralleled 10 phase group | 0.00176 | 0.00190 | 0.00162 |          |          |          |
|  | Nom.    | +5%     | -5%     | Nom.     | +5%      | -5%      |
| Line to line paralleled 10 phase group               | 0.00312 | 0.00328 | 0.00296 |          |          |          |

## Coupling Disc Torque (Lubricated with Texaco Threadtex)

|  |                        |
|--|------------------------|
| Six bolt application                   | 2440 N.m (1800 ft-lbs) |
| Twelve bolt application                | 1830 N.m (1350 ft-lbs) |
| Engine To Generator Coupling Bolt Nuts | 400 N.m (295 ft-lbs)   |

**EQUIPMENT LIST**

|  |                                      |
|--|--------------------------------------|
| Pyrometer                              | 8027937                              |
| Induction Heater                       | 8041446                              |
| Stone (1" x 1' 1/2" x 5") - 2 required | 8204167                              |
| Collector Ring Grinder                 | 8219264                              |
| Collector Ring Grinder Adapter:        |                                      |
| Small bearing (215 mm) generator       | 8364940                              |
| Large bearing (260 mm) generator       | 9506268                              |
| Hydraulic Pump                         | 8309742                              |
| Megohmmeter Tester                     | 8306539                              |
| High Potential Tester                  | 8324253, 8212404<br>8212405, 8212406 |
| Rotor Shaft Jacking Fixture            | WS16288                              |

|  |                  |
|--|------------------|
| Grease Contour Mask, Bearing Cap And Cover         | File Drawing 919 |
| End Housing Holding Fixture                        | File Drawing 753 |
| Arbor Fixture                                      | File Drawing 754 |
| Collector Ring, Seals, and Bearing Puller Assembly | File Drawing 755 |
| Bearing Alignment Disc                             | WS19391          |

**MATERIAL LIST**

|   |                 |
|---|-----------------|
| Texaco Threadtex 18.93 litres (5 gallons) | 8307731         |
| Red Air Drying Enamel:                    |                 |
| .95 litres (1 quart)                      | 8061130         |
| 18.93 litres (5 gallons)                  | 8084876         |
| Molykote Lubricant:                       |                 |
| .473 litres (1 pint) aerosol              | 9316707         |
| .473 litres (1 pint) paste                | 9517921         |
| Bearing Lubricant                         | Esso Unirex N-2 |
| 13.61 kg (30 lb)                          | 9507146         |
| 54.43 kg (120 lb)                         | 9507147         |