MAINTENANCE INSTRUCTION

MAIN GENERATOR—TYPES D32, D22, D12

DESCRIPTION

The Model D32, D22, and D12 generators are similar in appearance and construction. The primary external difference between the Model D32 and the Models D22 and D12 generators is the removal of the external bus bars on the D32 generator, Fig. 1.

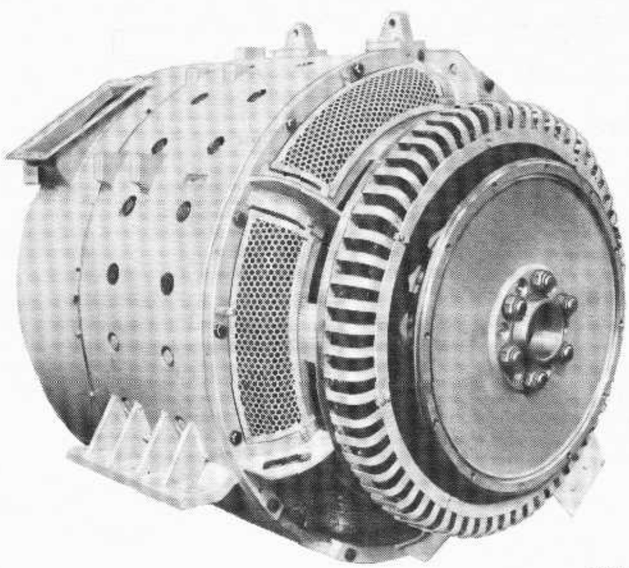

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Fig.1 - D32 Generator Assembly

The primary external differences between the various D32 generators involve leads, generator feet, bus bars, the location of the air box, and whether the generator is self-ventilated or force-ventilated.

The Models D32D and D32E have a separately excited field in place of a combination battery field plus a shunt field. The two models differ only in the type of field coils which their stator assemblies contain. The D32D and D32E generators are interchangeable as an assembly and their stators may be interchanged as an assembly.

The data contained in this Maintenance Instruction will apply to Models D32, D22, and D12 generators unless specifically identified.

The generator is directly connected to the diesel engine by a flexible coupling. The engine rotates the generator which produces a nominal 600 volts DC. Output of the generator is applied to the locomotive traction motors. Changes in motor connections across the generator, as well as application of shunting resistance around the traction motor fields occur automatically as train speed increases. These changes are accomplished in order to stay within the voltage limitations of the generator at higher locomotive speeds and within the current limitations at heavy drag load speeds.

The generator is made with numerous windings, Figs. 2, 3, and 4, that perform the following:

1. Starting Field

   Energized by the locomotive battery during engine start in order to motor the generator and crank the diesel engine.

2. Interpole

   Assists reversal of current in the armature windings during commutation.

*This bulletin is revised and supersedes previous issues of this number.
Areas of change are indicated by vertical bars in the margins.

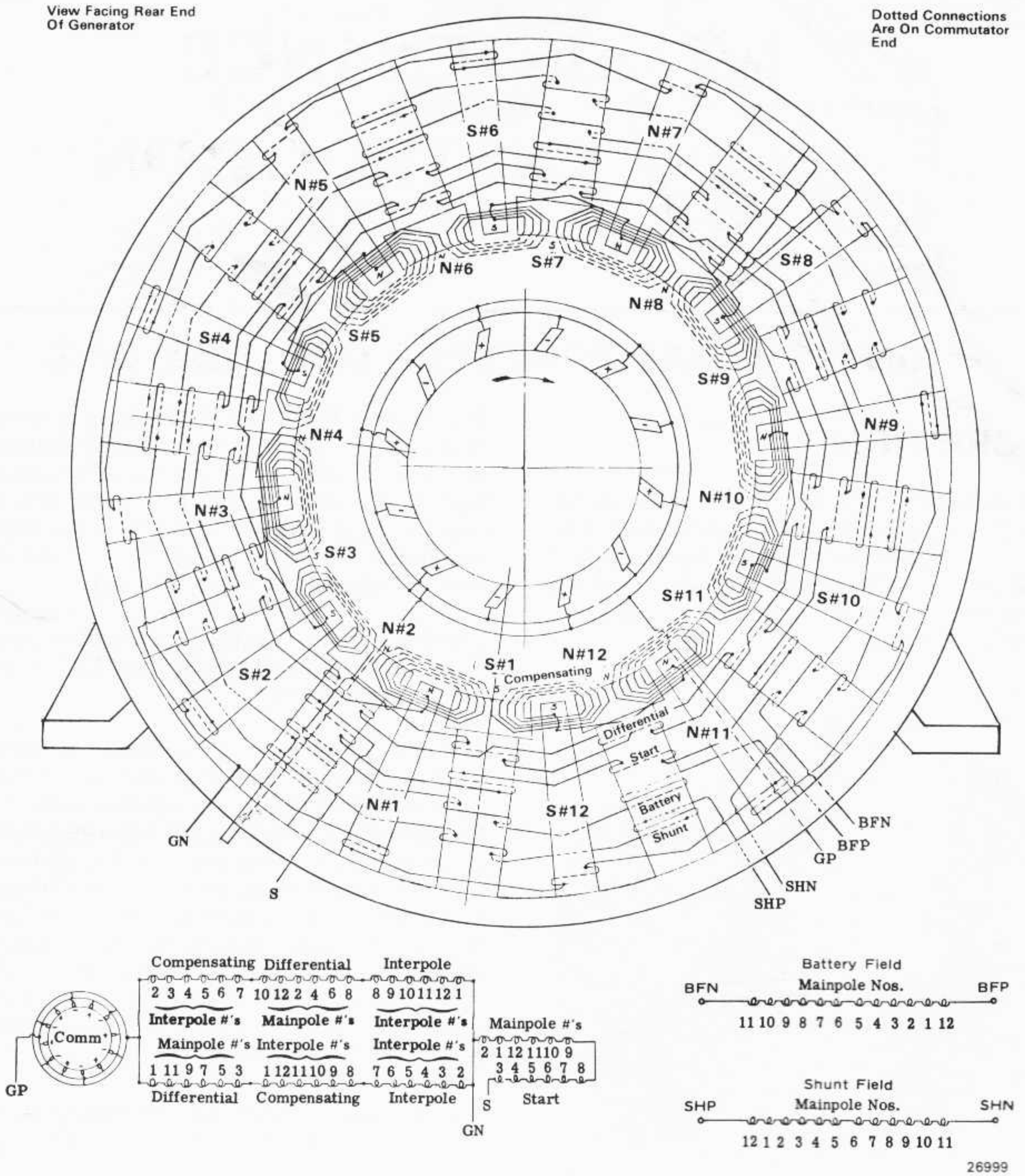

Fig.2 – Model D12 And D22 Generator, Wiring Diagram

3. Compensating Field

   Helps prevent the armature from distorting the magnetic flux created by the generator fields.

4. Differential Field

   Alters generator characteristics so that a relatively small change in the level of excitation is sufficient to obtain a constant kilowatt generator output.

5. Battery Field (Not on Model D32D or D32E)

   A separately excited field connected to the battery and auxiliary generator circuit. The battery field is under control of the load regulator which serves to maintain a constant

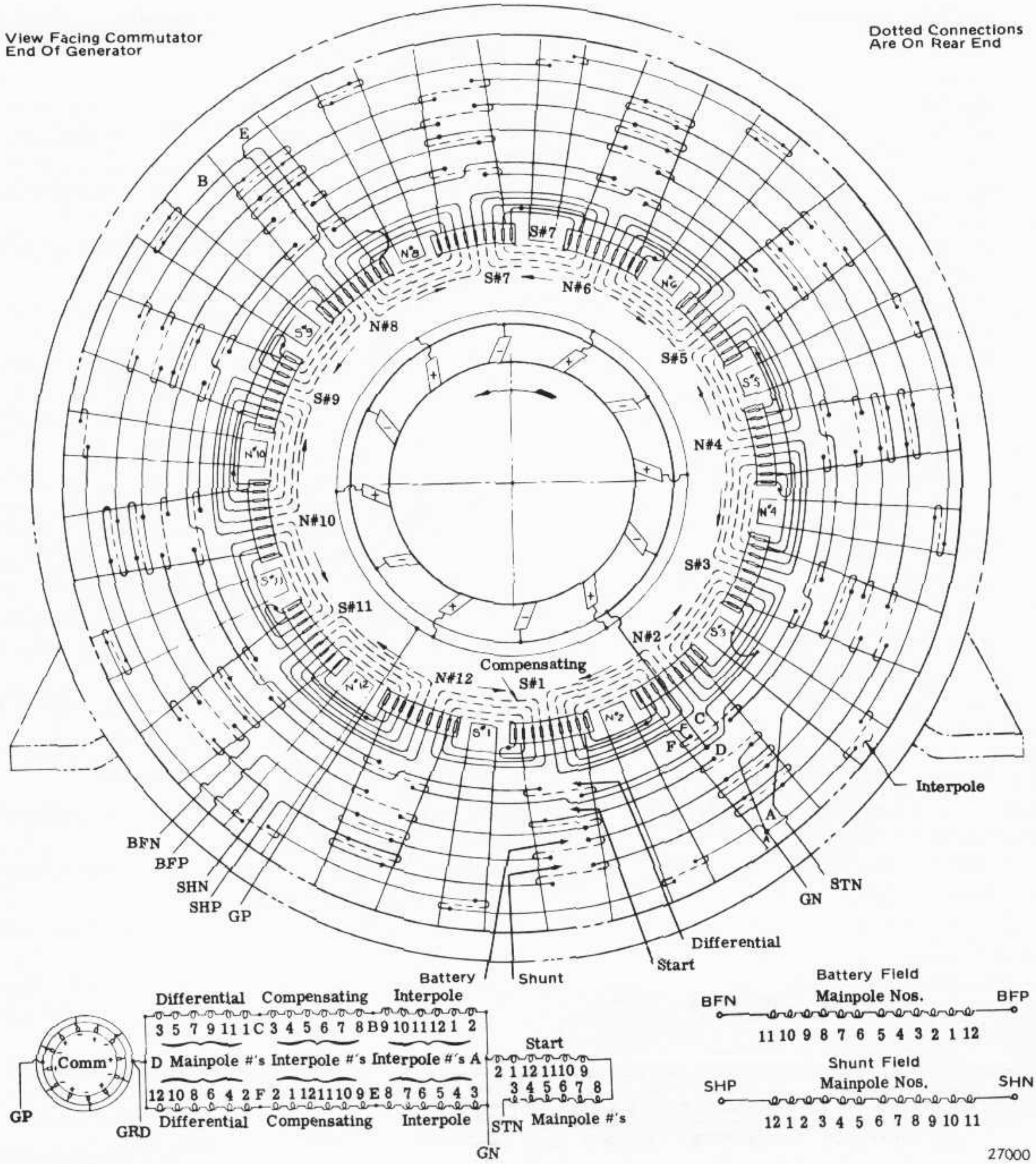

Fig.3 – Model D32 (Except D32D And D32E) Generator, Wiring Diagram

horsepower demand on the engine for any ampere demand within the capacity of the generator and load regulator.

6. Shunt Field (Not on Model D32D or D32E)

A small portion of generator output is fed back and used to excite the shunt field. An external resistance connected in series with the shunt field is used to change generator characteristics in relation to the number and connection of motors powered by the generator.

7. Separately Excited Field (Models D32D and D32E only)

The D32D and D32E generators are not self excited and do not contain a shunt field. All generator excitation is provided by a separately excited field. The field is made up of two coils on each main pole as follows:

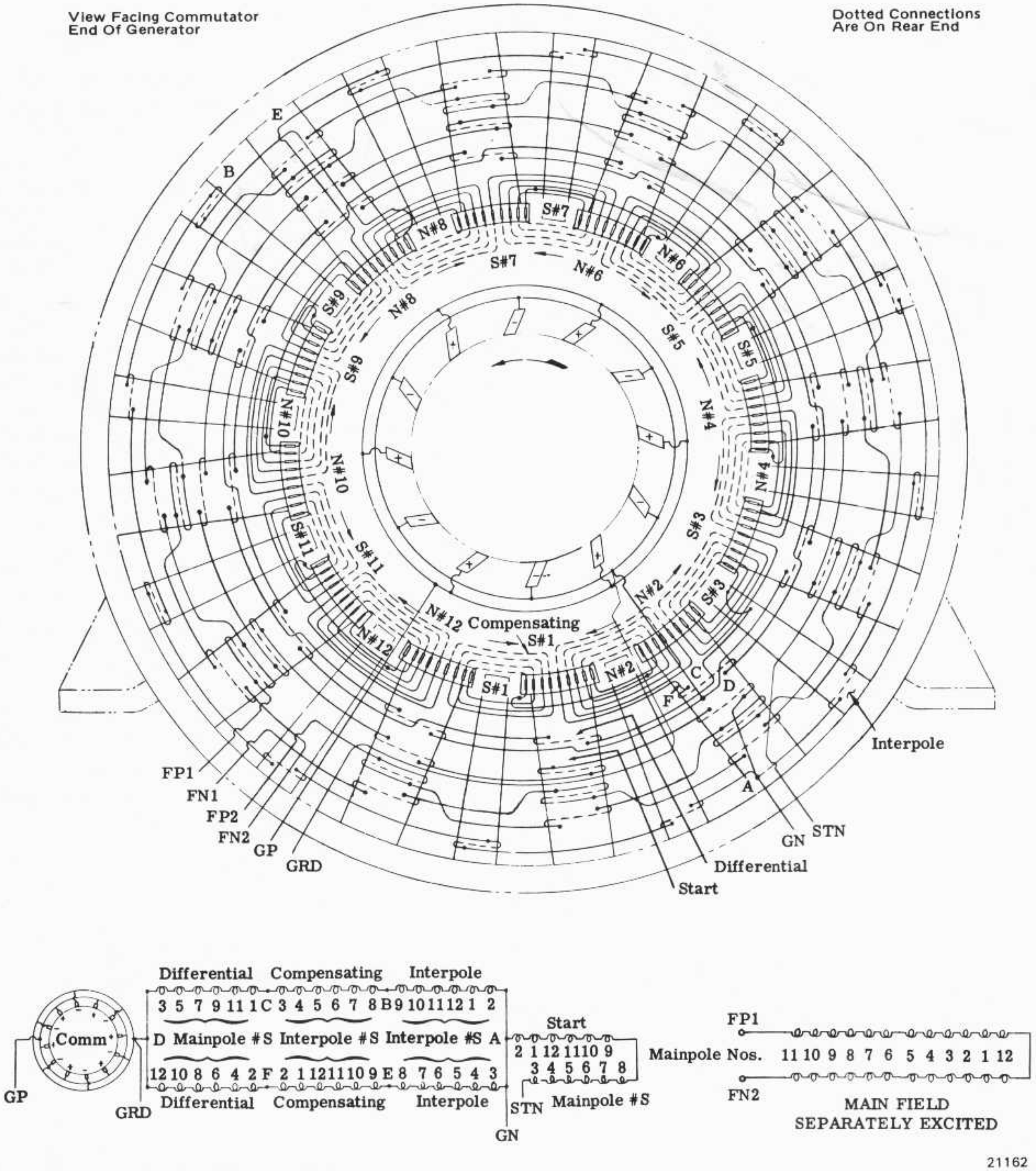

Fig.4 – Model D32D And D32E Generator, Wiring Diagram

Model D32D

a. Inner coil consisting of nominally 47 turns. The inner coil is wound in a "crossed" manner.

b. Outer coil consisting of nominally 97 turns. The outer coil is wound in an "open" manner.

Model D32E

a. Inner coil consisting of nominally 66 turns. The inner coil is wound in a "crossed" manner.

b. Outer coil consisting of nominally 78 turns. The outer coil is wound in an "open" manner.

The separately excited field consists of 12 main poles and a total of 24 main pole coils. The coils are connected in two series groups of 12 coils each, with the coils connected alternately inner and outer on adjacent poles. This is possible due to the fact that the coils are wound alternately crossed and open, permitting opposite polarity at adjacent poles. The two series groups of 12 coils are connected to provide a total series of 24 coils.

Most Models D12, D22, and D32 generators have an auxiliary alternator assembly bolted directly to the generator stator frame. The alternator rotor is bolted directly to the generator armature spider. When connected the alternator becomes an internal part of the generator.

The alternator provides a means of driving accessories such as cooling fans and inertial filter blower motor. On locomotives equipped with D32D or D32E generators, it provides generator excitation current.

For maintenance of the D14 alternator, refer to Maintenance Instruction M.I. 3306. For maintenance of the D18 alternator, refer to Maintenance Instruction M.I. 3307.

The extent of maintenance required is determined by the operation and service to which the generator is subjected. Inspections and maintenance should be performed on the systematic basis outlined in the Scheduled Maintenance Program.

GENERATOR CLEANING

Both the exterior and interior 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 the insulation.

Clean, bound-edge, lintless wiping cloths should be used as necessary to remove oil, grease, and accumulations of dirt.

In cases where air and dry wiping cloths prove incapable of removing caked grease and dirt, a stiff brush and soft wood or fibre scrapers may be used. In severe cases it may be necessary to dampen a cloth in solvent such as Stoddards Solvent to loosen and remove imbedded deposits. Every precaution should be taken to keep the solvent off the commutator and copper parts as well as insulated coils and windings.

CAUTION

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

Chlorinated hydrocarbon type cleaning solvents are not recommended for use on the equipment because of the possibility of insulation damage. This type solvent can deteriorate semi-cured silicone rubber and can swell ethylene-propylene rubber, natural rubber, neoprene, and hypalon during extended soaking periods. The vapor state at 70° C (160° F) attacks uncured silicone rubber within 20 minutes. The vapors of these solvents also have an adverse effect on commutation. Special care is also necessary to avoid subjecting the polyester glass insulated brush holder studs to alkaline type cleaning solutions.

BEARING MAINTENANCE

The bearing requires maintenance at intervals recommended in the Scheduled Maintenance Program. This can be accomplished either by removing the generator from the installation and performing the Generator Disassembly procedure of this instruction or by maintaining the bearing with the generator in place.

BEARING MAINTENANCE WITH GENERATOR IN PLACE

Perform the entire following procedure for a generator-alternator unit. If the generator does not have an attached alternator and therefore no collector ring assembly, perform only Steps 7 through 18.

1. Remove collector ring cover, Fig. 5.

NOTE

On older units equipped with a compressor coupling, remove compressor guard.

2. Remove brushes from collector ring brush holders and remove brush holder cable connections. Remove brush holders.
3. Remove field lead connections from terminal posts of collector ring assembly.
4. Remove shaft flange and conduit bushing from end of shaft.
5. Place an extension cup around field leads and bolt extension cup to shaft as shown in Fig. 6.

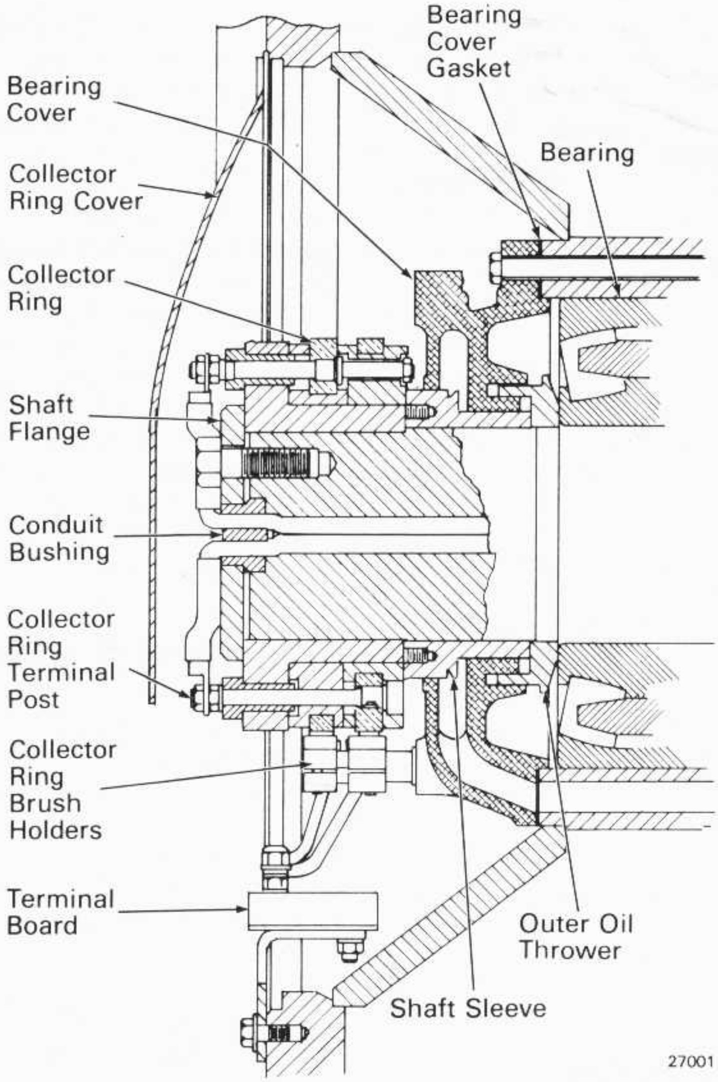

Fig.5 – Collector Ring And Bearing Front, Cross-Section

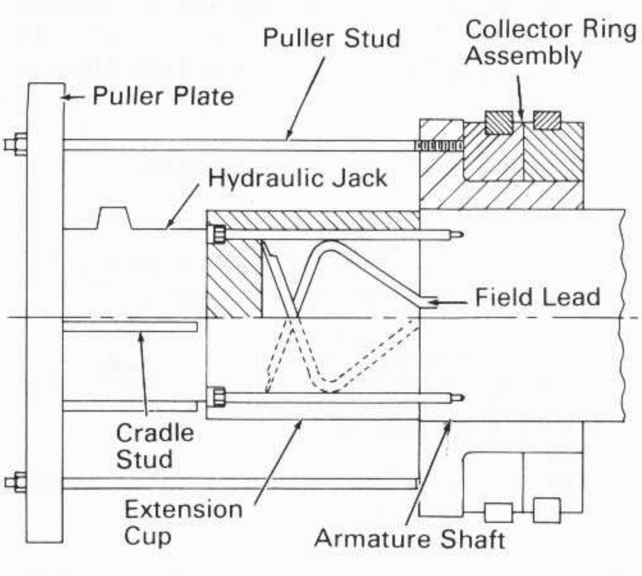

Fig.6 – Collector Ring Removal

6. Install a puller plate and puller studs to remove collector ring assembly as shown in Fig. 6. Place a hydraulic jack between extension cup and puller plate, supported by cradle studs of puller plate. Remove collector ring using hydraulic jack.

NOTE

On older units with compressor coupling, compressor coupling must be removed with collector ring.

7. Apply studs and puller plate and remove armature shaft sleeve.

8. Remove bolts from bearing cover and remove bearing cover. It may be necessary to tap cover with a rawhide mallet or soft wood hammer and gently pry cover with a pry bar to remove.

9. Inspect grease in the bearing cover and inspect the 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 with new parts. Refer to Generator Disassembly procedure of this instruction to remove bearing associated parts.

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

NOTE

On older bearing covers with labyrinth grooves, fill labyrinth grooves flush with Esso Unirex N-2. This grease need not be measured.

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

CAUTION

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

12. Carefully weigh the grease for the bearing cover cavity. Refer to Service Data for quantity.

NOTE

If generator bearing had been greased with Shell Cyprina RA Grade 3 grease, Esso Unirex N-2 may be mixed with the Shell Cyprina RA Grade 3 during maintenance performed while generator is connected to engine. When generator is overhauled away from the installation, there is no reason to mix grease and only Esso Unirex N-2 should be used.

13. Pack grease into the bearing cover cavities. Leave a free space at the top of the bearing cover to limit grease churning and liquefaction of the grease. Using a spatula or putty knife, roughly form the grease to desired contour as shown in Fig. 7, and apply grease mask. Refer to Service Data for grease mask part number. The grease cavity should be filled to complete an arc of 240° to 270°. The grease arc must be packed without air voids.

    Rotate grease mask to form proper contour, keeping grease mask seated. Several turns may be required to get proper contour. Use spatula or putty knife to fill in low spots with grease from the grease mask blade. The small amount of grease retained on the blade should be removed and applied to the ends of the grease arc. The contour should be built up to the limits of Fig. 7.

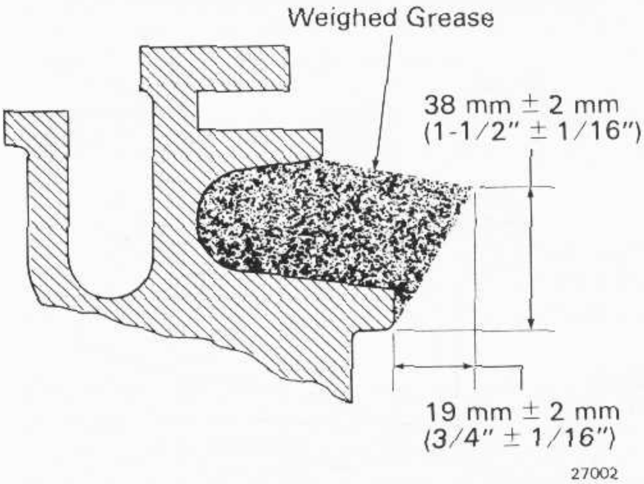

Fig.7 – Application Of Grease To Bearing Cover

14. 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 foreign substance into the bearing. Repack all spaces on the exposed side of the bearing with grease. Pack as much grease as can be solidly pressed into the cage and roller assembly. Esso Unirex N-2 can be added to the grease already in the bearing.

15. Heat the armature shaft sleeve in an oil bath, electric oven, or induction heater to 127° C (260°F) and shrink to shaft. If oil bath is used for heating, remove oil from sleeve with clean, bound-edge cloths prior to shrinking to the shaft. When using induction heater, pyrometer readings (with heater current off) should be taken periodically.

16. Install the grease bearing cover with a new gasket, Fig. 5. 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).

17. After armature shaft sleeve is heated to the proper temperature, shrink sleeve to the shaft. Allow sleeve to cool to room temperature.

18. Place collector ring on induction heater and heat to 120° C (248° F). Pryometer readings (with heater current off) should be taken periodically. Clean keyway and assemble key to shaft. After heating, place collector ring on shaft to shrink. Refer to Fig. 5.

19. Install alternator brush holder assemblies on posts pressed in bearing cover. Torque brush holder clamping bolts to 20-27 N·m (15-20 ft-lbs). Set brush holder assemblies so that a 3 mm (1/8″) clearance is obtained between bottom of each brush holder and the collector ring, Fig. 8.

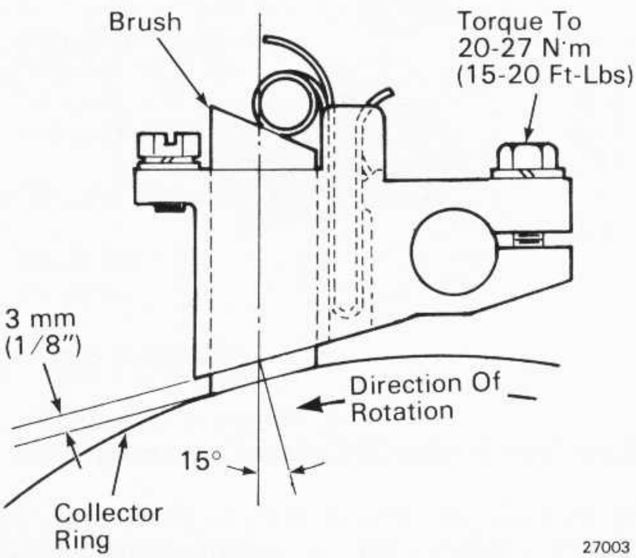

Fig.8 – Collector Ring Brush Holder Installation

20. Measure spring tension with the spring 3 mm (1/8″) above the top of the brush holder. Spring tension should be 0.68 kg to 0.79 kg (1-1/2 to 1-3/4 lbs).

NOTE

Care must be used when measuring spring tension because of brush spring and finger friction. Wiggle brush finger and spring while holding tension or take an average reading while raising or lowering brush fingers with tension scale.

21. Install brushes in brush holders. Ensure the brush holder assembly is securely mounted and the cable and brush shunt connections are tight.

NOTE

On older units with compressors, apply compressor coupling to collector ring and bolt in place.

22. Assemble conduit bushings on field cables and insert conduit bushing into end of shaft. Bolt shaft flange to end of shaft.

NOTE

If new cables are used, cut and skin to allow enough slack in cables to clear bolt heads. Solder terminal lugs to cables.

23. Apply 16 mm (5/8″) loom insulation over field cables and tie cables with torpedo twine. Apply cables with terminals to posts with brass studs. Cables are not marked for any particular post. Paint cables and loom with red air-drying enamel.

24. Connect drain pipe to bearing cover and bolt pipe clamp to end housing, if unit so equipped.

COLLECTOR RINGS AND BRUSHES
(Generator-Alternator Unit Only)

When the generator has an alternator attached, the generator is equipped with a collector ring assembly and associated equipment at the commutator end shaft to provide excitation to the alternator.

Collector rings 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.

Collector ring concentricity should be within 0.15 mm (.006″) total indicator reading (rings installed on generator), and lateral runout within 0.8 mm (1/32″). If these tolerances are exceeded, the rings will have to be machined or stoned to bring rings 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 225.42 mm (8.875″). If rough rings cannot be cleaned up without going below the minimum diameter, the rings should be replaced with new rings.

A collector ring grinder that may be mounted to the generator is available. Refer to Service Data for grinder part number.

Remove a brush holder assembly and install the grinder to the applicable tapped holes or studs provided.

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. It has continued abrasive action.

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 aluminum oxide paper 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 aluminum oxide paper 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.

COMMUTATOR BRUSH HOLDERS

NOTE

Locomotive operating conditions such as extended periods of idling or light load conditions can cause a deterioration of the commutator surface resulting in surface irregularities. The surface irregularities can cause brush and brush holder pressure arm and pressure spring problems. This condition can usually be eliminated by resurfacing the commutator and replacing the original equipment brushes with padded brushes. Refer to Commutator section of this Maintenance Instruction for Commutator Surface Conditions and Commutator Grinding procedure. Refer to Service Data for replacement part number of padded brush.

ADJUSTABLE SPRING TYPE BRUSH HOLDERS

The D12, D22, and current (June of 1982) D32 generators are equipped with adjustable spring type brush holders as shown in Fig. 9. Refer to the following tables to upgrade former D32 brush holders and corresponding brushes.

FORMER D32 BRUSH HOLDER		REPLACED BY	
Part Number	Description	Part Number	Description
8331071	Constant Pressure Type	8084210	Adjustable Spring Type

FORMER D32 BRUSH		REPLACED BY	
Part Number	Grade	Part Number	Grade
8330994 9334437	DE-8 AC-127	8307806 9334438	DE-8 AC-127

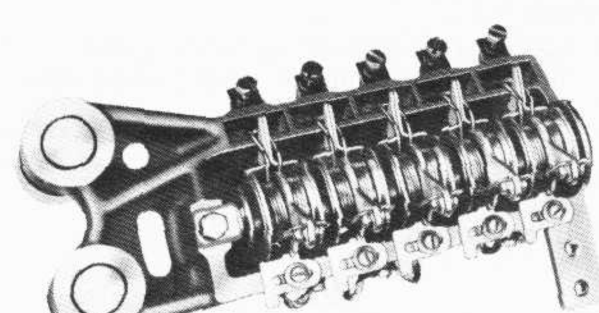

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Fig.9 – Adjustable Brush Holder Assembly

ADJUSTABLE SPRING TENSION

The adjustable spring tension should be at the limits as specified in the Service Data. It is important that all brushes be adjusted to the same pressure. Unequal brush pressure will cause unequal current distribution in the brushes. The spring type brush holder may lose some tension during the first few weeks of operation. Spring tension should be checked during this period. Measure the spring tension with the lever arm 3 mm (1/8") above the top of the brush holder box as shown in Fig. 10. The spring tension is adjusted as follows; refer to Fig. 11.

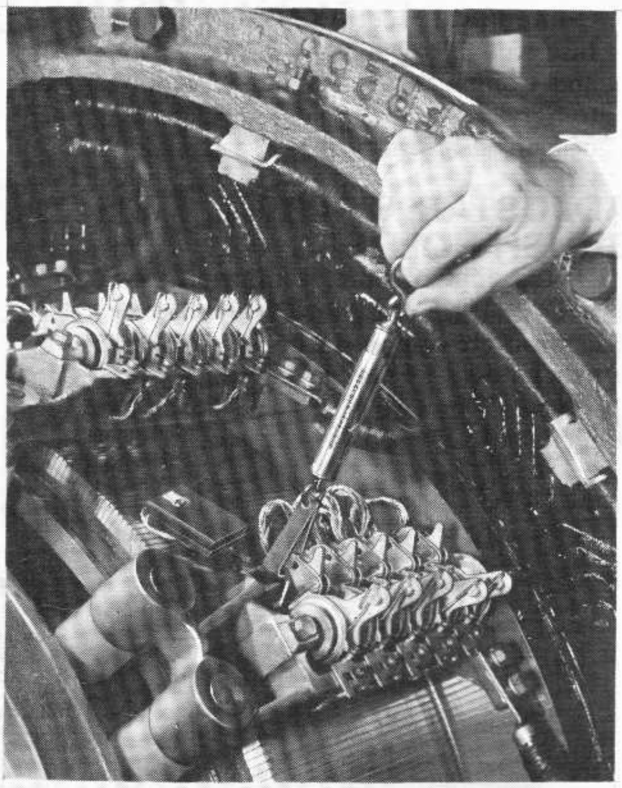
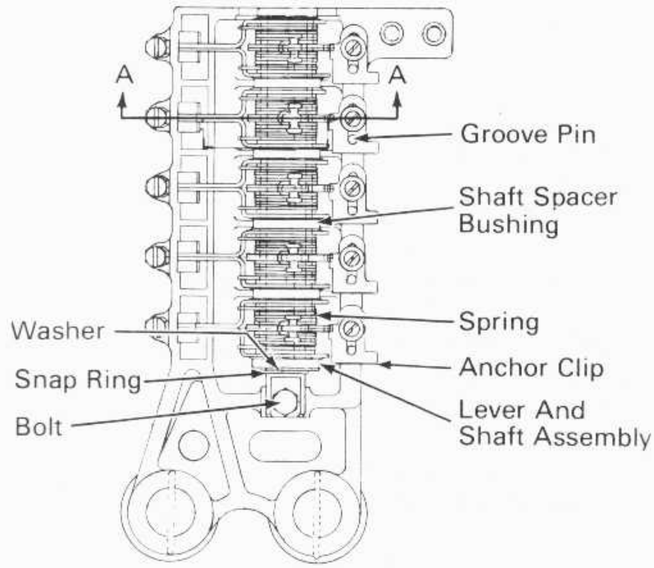


Fig.10 – Measuring Brush Spring Tension

1. Release the spring from the anchor pin and remove brushes from brush holder.
2. Loosen screw and slide anchor clip away from thimble. Adjust thimble to suit (usually second or third slot).
3. Install anchor clip and secure with screw.
4. Insert springs to anchor pin.

NOTE

Care must be used in measuring spring tension because of brush spring and finger friction. Wiggle brush finger and spring while holding tension or take an average reading while raising and lowering brush fingers with tension scale.



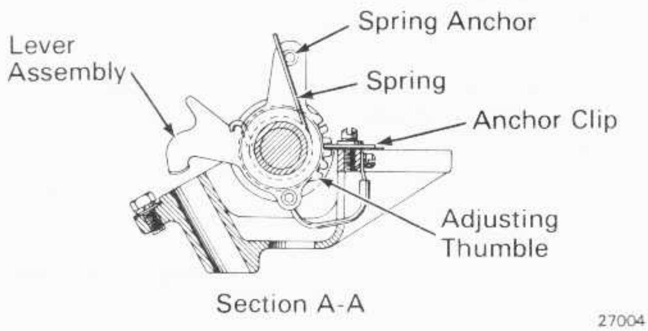


Fig.11 – D12, D22, And Current D32 Generator Commutator Brush Holder Assembly

5. Ensure the brush holder assembly is securely mounted and the cable and brush shunt connections are tight.

LEVER AND SHAFT ASSEMBLY REMOVAL

1. Free springs from spring anchor pins, Fig. 11.
2. Remove bolt from shaft assembly and remove shaft and lever assemblies from brush holder.
3. Using snap ring pliers, remove snap ring and washer. The individual assemblies may now be slipped off the shaft.

LEVER AND SHAFT ASSEMBLY INSTALLATION

1. Assemble lever and shaft assembly as shown in Fig. 11. When the assembly is placed on the shaft, assemble washer and a new snap ring to the shaft. Use a snap ring installing tool to apply snap ring to shaft.

2. When installing a complete lever and shaft assembly, a U-shaped tool can be made as shown in Fig. 12 to aid in the assembly. The U-shaped tool is used as shown in Fig. 13.

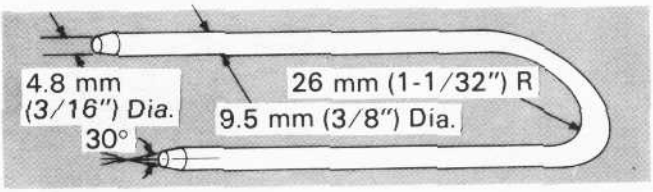


Fig.12 - Lever And Shaft Assembly Alignment Tool

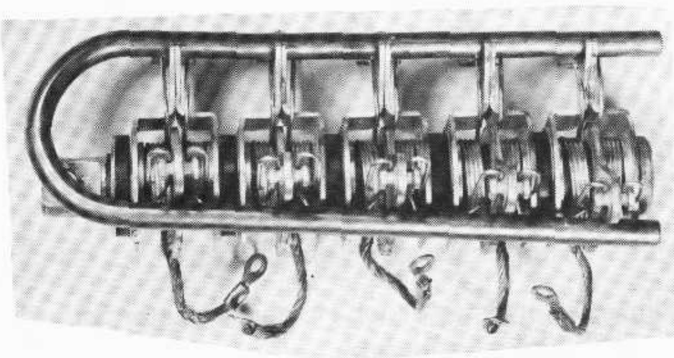


Fig.13 - Lever And Shaft Assembly Alignment Tool Application

3. Apply anchor clips to hold adjusting thimble, and set spring tension as described at beginning of section.

4. Brush holders must be adjusted to maintain a dimension of 3 mm (1/8") to 5 mm (3/16") between the bottom of the carbonway and the commutator surface. The brush rigging is arranged so that the brush holder may be moved toward commutator surface as the commutator surface wears or is turned.

5. Ensure brush holder is securely mounted and the cable and brush shunt connections are tight.

CONSTANT PRESSURE TYPE BRUSH HOLDERS

D32 generators built prior to June of 1982 are equipped with brush holders which incorporate five constant pressure spring housing assemblies as shown in Fig. 14. Each spring housing assembly holds two brushes. The spring housing assembly is constructed of a polyester glass holder with two constant pressure stainless steel springs which exert a pressure of 1.1 kg (2.43 lbs) on each brush wafer. To remove the brushes from the brush holder, the spring housing assembly must be removed by pressing the springs on each side of the assembly as shown in Fig. 15. This releases the spring housing assembly from the brush holder and allows the brushes to be removed from the spring housing assembly.

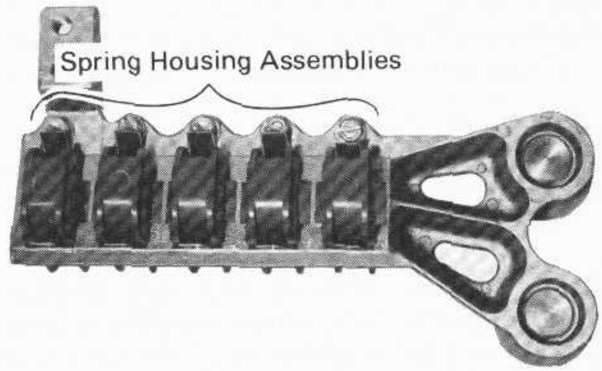


Fig.14 - Constant Pressure Brush Holder Assembly

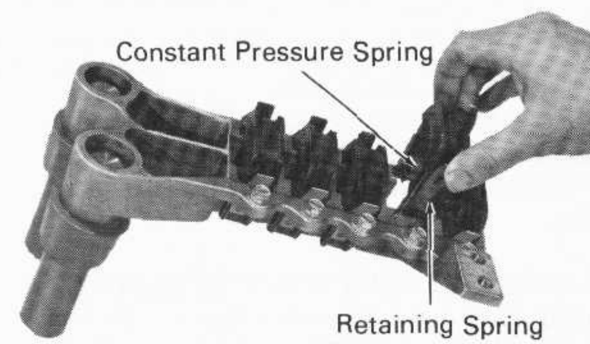


Fig.15 - Removal Of Brush Pressure Spring Housing From Constant Pressure Brush Holder

Whenever the brushes are changed out or inspected, the constant pressure spring housing assemblies should be qualified. Any defects in the constant pressure springs or in the retaining springs are cause for replacement. Care should be taken to expand the constant pressure springs so that the entire length can be inspected. On re-application, the retaining springs should lock securely into the brush holder assembly.

The constant pressure brush holder springs need no adjustment, as the pressure will remain the same through the brush life, regardless of the brush length.

Brush holders should be periodically checked and adjusted to maintain a dimension of 3 mm (1/8") to 5 mm (3/16") between the bottom of the carbonway and the commutator surface.

COMMUTATOR BRUSHES

The generators are equipped with a two-wafer brush. Five of these two-wafer brushes are used in each of the twelve brush holders. The brush is mounted in the brush holder so that the heel or short side of the brush makes contact with the commutator first, resulting in reduced friction and copper drag.

Brushes should be carefully inspected and replaced with new brushes if chipped, broken, or worn to the condemning limit. Refer to Service Data for wear limits of brushes.

Brushes may be replaced with new brushes individually as they wear to the condemning limit. Replacement brushes should be of the same type and grade as the other brushes. Mixing brushes in the same generator can be detrimental to successful operation.

When a full set of brushes is replaced with new brushes, it is important that the brushes are seated properly.

CAUTION

The friction created by improperly seated or unseated brushes may result in the commutator heating to the melting point and throwing solder.

Brushes should be seated by rotating the generator and using a seating stone as shown in Fig. 16. Refer to Service Data for seating stone part number. A 90% seat is satisfactory.

BRUSH HOLDER INSULATOR STUDS

Brush holder studs should be kept clean and free of defects. The polyester insulated type brush holder studs, Fig. 17, are unusually resistant to flashover damage. If flashover damage should occur, the insulator studs usually can be restored to satisfactory

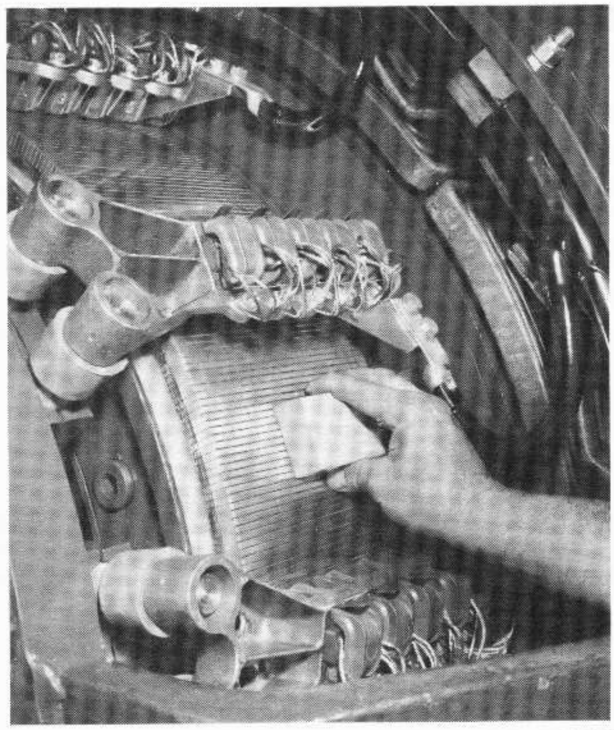


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Fig.16 - Seating Brushes

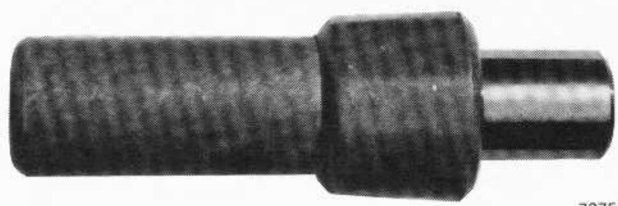

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Fig.17 - Polyester Brush Holder Insulator Stud

condition by polishing them with fine sandpaper. Polyester glass material should never be subjected to alkaline cleaning solutions.

NOTE

Early model brush holder insulator studs were insulated with porcelain and should be replaced with the polyester insulated studs. Polyester is more durable and does not become permanently carbon tracked.

When stud insulation is broken, cracked, or burned to the extent that it cannot be cleaned, much time can be saved by replacing the stud with a new stud.

Brush holder insulator studs have a silicone rubber insulated sleeve over the base of the studs, Fig. 18. When replacing or reconditioning brush holder assemblies, ensure insulated sleeves are in place.

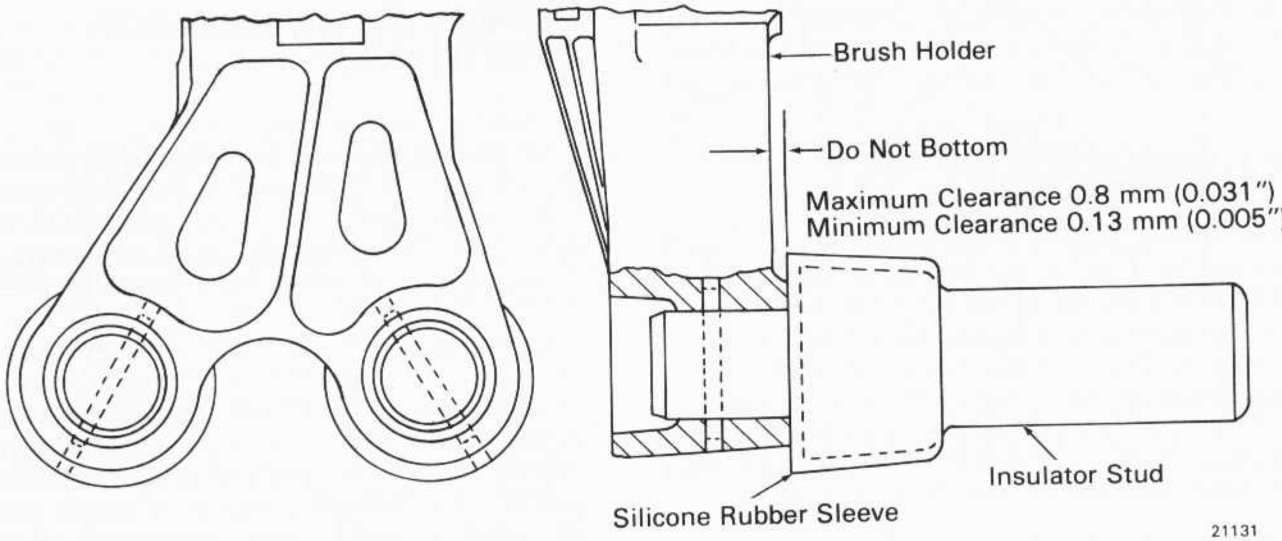

Fig.18 – Brush Holder Insulator Stud Installation

Replacement polyester glass insulated studs are available in the following sizes:

Standard size - 8159003

To be used in new brush holders or when stud holes are within 25.235 mm ± 0.013 mm (0.9935" ± 0.0005").

0.05 mm (0.002") Oversize - 8209068

0.20 mm (0.008") Oversize - 8219773

For stud holes which have had a standard size pressed out.

The following studs can be used for extensively scored stud holes which have been reamed out.

0.79 mm (0.031") Oversize - 8209069

0.84 mm (0.033") Oversize - 8222653

1.57 mm (0.062") Oversize - 8222652

1.65 mm (0.065") Oversize - 8222654

The oversize studs may be identified by the number 2, 8, 31, 33, 62, or 65 stamped on the bottom of the stud. The number is in reference to the amount oversize in thousandths of an inch. For example, the number 2 identifies the 0.05 mm (0.002") oversize stud. The number 65 identifies the 1.65 mm (0.065") oversize stud.

INSULATOR STUD INSTALLATION

A sleeve-type tool made of half-hard brass, Fig. 19, should be used for pressing the studs into the brush holder .

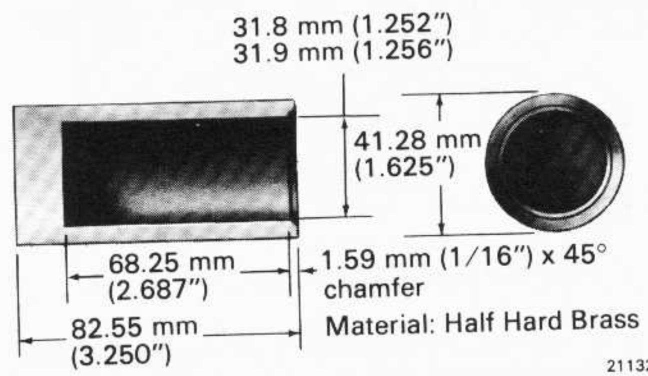

Fig.19 – Insulator Stud Installation Tool

To replace the brush holder insulator studs, perform the following procedure:

1. Press out brush holder insulator stud, shearing retaining pins.

2. Clean up stud holes of brush holder, if required.

3. Select proper oversize stud. Ensure that 0.05 mm ± 0.025 mm (0.002" ± 0.001") press fit is obtained. Press in stud using sleeve-type tool, Fig. 19. Clearance between the stud shoulder and brush holder must be maintained to ensure the insulation does not get damaged against the brush holder. Refer to Fig. 18.

4. Drill and pin brush holder and stud. Use a No. 23 drill and a 4 mm x 35 mm (0.156" x 1-3/8") pin. Peen over hole on both ends after installing pin.

COMMUTATOR

The commutator is a vital area on the generator. It should be kept in the best condition possible. Inspections should be made at frequent intervals to ensure detection of surface faults before loss of service or before repairs become necessary. Such conditions as film stripping, burned bars, high or low bars, high mica, or flat spots become more serious with time. When a defect is found, determine the cause and correct as soon as possible.

CREEPAGE SURFACES

The creepage areas, Fig. 20, should be cleaned and repainted with red air drying enamel as follows:

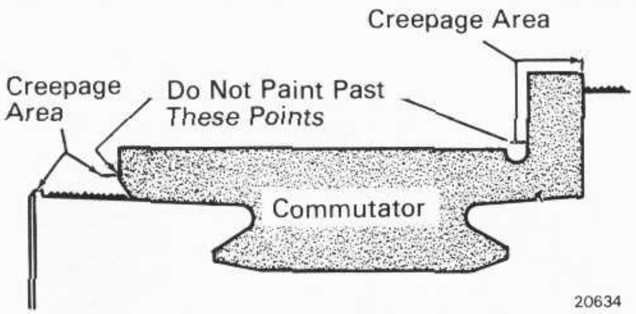

Fig.20 - Commutator Creepage Areas

1. Clean surfaces thoroughly with alcohol. Remove any trace of carbon.

2. Apply red air drying enamel with a clean brush to the creepage surfaces. Make as thin a coat as possible applying the enamel evenly, leaving no dabs or overlapping areas. Use "Xylol" to thin enamel, if required. Do not get enamel into commutator slots or the relief at the bottom of the commutator neck.

NOTE

Do not apply red air drying enamel over carbonized or charred insulation. If the insulation cannot be cleaned up, the generator should be removed for permanent repairs.

3. Wait until enamel is dry before running generator.

COMMUTATOR SURFACE CONDITIONS

Commutator surface irregularities can cause frayed brush shunts, highly polished brush to brush box contact surfaces, excessively worn brush pressure arms, broken pressure springs, and rapid brush wear. Repeated monitoring of these conditions can determine when a commutator should be ground.

Some slight commutator bar movement can be caused by road seasoning (repeated heating and cooling of the commutator), standstill burns, and overspeed. The bar movement, depending upon the number and location, can damage the commutator and brushes. A commutator with certain profile irregularities could operate satisfactorily as lower speeds, but when operated at higher speeds, could cause problems. A very rough commutator will have these same problems occurring at even lower speeds.

A rough commutator may not be obvious. The commutator should be checked with a dial indicator attached to the motor or generator so that the plunger of the indicator rides on the commutator surface. Ensure the dial indicator rides on one of the brush tracks. Rotate the armature slowly and carefully observe the dial indicator indications. The overall minimum and maximum indications of the dial indicator are not applicable as a measurement of commutator irregularity. Commutator irregularity is concerned with bar to bar movement. An example of this would be to have readings around the commutator that have a total variation of 0.05 mm (0.002"), however hidden within the 0.05 mm variation are six low areas, each spanning one or more bars. This commutator would cause the brushes to bounce with resultant damage. A commutator having a total variation of 0.102 mm (0.004") with the minimum and maximum readings 180° apart is an acceptable commutator whereas the first example, 0.05 mm variation with several low areas, is not acceptable even though the total variation is much less. It is difficult to give a number value which would determine when a commutator should be ground. The values obtained by dial indicator must be evaluated with respect to performance of the generator (brush problems, flashovers, etc.) and a certain amount of personal judgement must be used. A useful "rule of thumb" is that any condition worse than 0.05 mm in a six (6) bar span calls for grinding the commutator.

Resurface the commutator by turning in a lathe or by the use of a grinder and grinder adapter. Hand stoning is definitely not recommended.

COMMUTATOR GRINDER MAINTENANCE

In order to produce an acceptable commutator surface finish, it is imperative that the jig stoning fixture be maintained in good condition. The use of a poorly maintained or incorrectly adjusted grinder will result in perpetuating the surface irregularities. Refer to Fig. 21 and check the grinder as follows:

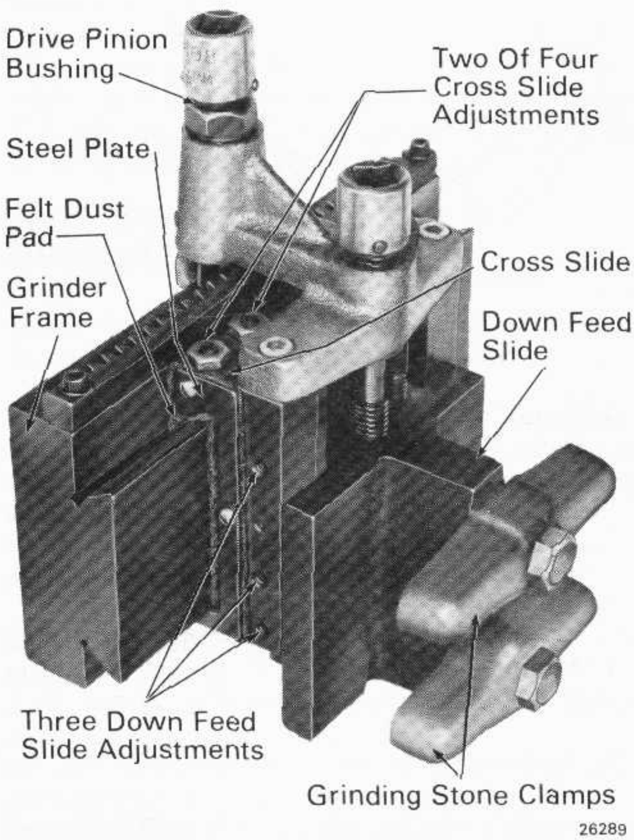

Fig.21 - Commutator Grinder Adjustments

There can be no abnormal movement, however slight, between the grinder cross-slide and the grinder frame or between the down-feed slide and the cross-slide. The movement can be detected by placing a fingertip on the parting of the two pieces and attempting to move either one of the pieces in all directions other than the normal direction of travel.

The travel of the cross-slide should be smooth with no binding, jerking, or tightness during the full travel from end to end. Any binding or tightness in the cross-slide travel is usually the result of one or more of the four Allen screws being incorrectly adjusted. Jerky movement of the cross-slide travel is usually the result of either grinding dust trapped between the two sliding surfaces or an incorrectly adjusted or loose bushing on the pinion shaft.

The grinder must be periodically cleaned and adjusted. The frequency of the cleaning is determined by the use of the grinder and should be performed before there is any binding or jerky movement of the cross-slide.

Do not attempt to clean an assembled grinder by *dipping in a solvent or by using air pressure to blow* out dust. The grinder must be completely disassembled *to clean.*

GRINDER DISASSEMBLY

Refer to Fig. 21 to disassemble the grinder as follows:

1. Remove the three small screws securing the felt dust pad and steel plate to one end of the cross-slide.

2. Loosen the three small Allen screws on the side of the cross-slide and the four Allen screws on the top of the cross-slide approximately 1/2 turn. The four Allen screws on the top of the cross-slide have lock nuts which must be loosened before loosening the four Allen screws. The loosening of these seven Allen screws will make it easier to disassemble and reassemble the grinder.

3. Remove the two large Allen screws located on the top of the cross-slide casting.

4. The grinder can now be completely disassembled. Pull up on the down slide until it clears the cross-slide. Then move the cross-slide towards either end until it clears the frame.

GRINDER LUBRICATION

Apply a thin film of graphite oil or grease to the *sliding surfaces only.*

GRINDER REASSEMBLY

Refer to Fig. 21 and reassemble the grinder as follows.

1. Install one of the brass wear plates in the cross-slide slot and slide the cross-slide into the grinder frame. The two brass wear plates are interchangeable, but the one having the least amount of wear should be used in this step.

2. Adjust the four Allen screws located on the top of the cross-slide for smooth travel from end to end with no abnormal movement of any kind. This adjustment is usually a 1/4 turn loose after

lightly bottoming the Allen screw. When adjustment is completed, tighten the locking nut on each screw. Use Allen wrench to hold Allen screw when locking nut is tightened.

3. Place the brass wear plate in the down-feed slot on the cross-slide and install the down-feed slide into the top side of the slot.

4. Install and tighten the two Allen screws at the top of the cross-slide.

5. Adjust the three Allen screws for the travel of the down-feed slide. This adjustment is usually a 1/8 turn loose after lightly bottoming the Allen screw. The travel movement should be adjusted to have a slight resistance to movement. The adjustment of the down-feed slide is not as critical as that of the cross-feed slide because of the fewer number of times that the slide will travel full length.

6. Install the felt dust pad and steel plate removed from the cross-slide. The pad and plate have both a wide and narrow end. The wide end should be on the same side as the brass wear plate on the cross-slide.

COMMUTATOR GRINDING

Commutator surface irregularities such as etching, roughness, or slight burning can often be corrected by resurfacing, using a grinding fixture. Refer to Service Data for grinding tools required.

NOTE

In order to produce an acceptable commutator surface finish, it is imperative that the jig stone fixture be maintained in good condition. The in-feed and cross-feed gib ways must be clean and free from burrs so the device feeds smoothly. The gib keys must be adjusted so that no free play exists in the sliding assemblies, but not so tight as to cause binding. Refer to Commutator Grinder Maintenance Section prior to grinding commutator.

1. Remove all brushes from 8 of the 12 brush holders. Two of the remaining four brush holders should be positive polarity and two negative polarity. Refer to Fig. 22.

2. Remove a brush holder. Refer to Fig. 22 for suggested location. Install grinder supporting adapter in place of the removed brush holder.

NOTE

Tape the copper lug of the lead which was disconnected from the brush holder so it will not short against generator frame.

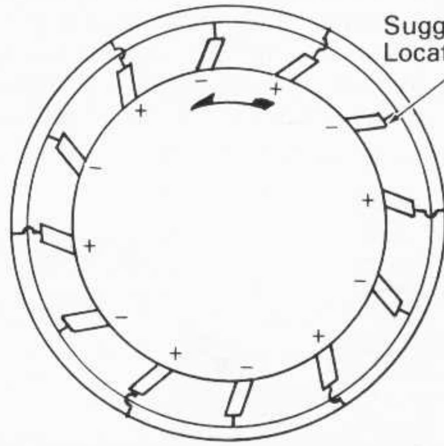

Fig.22 - Brush Holder Polarity

3. Install the alignment bar on the grinder down-feed slide. Check alignment bar contact to down-feed slide for zero clearance with a thickness gauge. Refer to Fig. 23. Any clearance at either side of the alignment bar contact surface indicates that the bar is not parallel to the grinder.

4. Mount the grinder with alignment bar on the grinder supporting adapter, Fig. 24.

5. Position the generator armature so that the alignment bar will contact the approximate center of the commutator bar. Parallel the alignment bar to the commutator surface using the small areas outside of the brush track at both ends of the commutator bar. The alignment bar should be within 0.08 mm (0.003") of paralleling the commutator bar.

6. Remove the alignment bar from the grinder and install the two grinding stones. Mount the stones so that they are seated squarely on the commutator. Pull stones away from the commutator using the grinder cross-travel feed.

7. Start the diesel engine and run at idle speed.

8. Feed grinding stones into commutator slowly using the down-feed handle until light contact is made. Proceed to grind the commutator by feeding the stones not more then 1/8 turn of the down-feed handle (45°) and move the stones across the commutator at a moderate speed for three complete passes. One pass being the

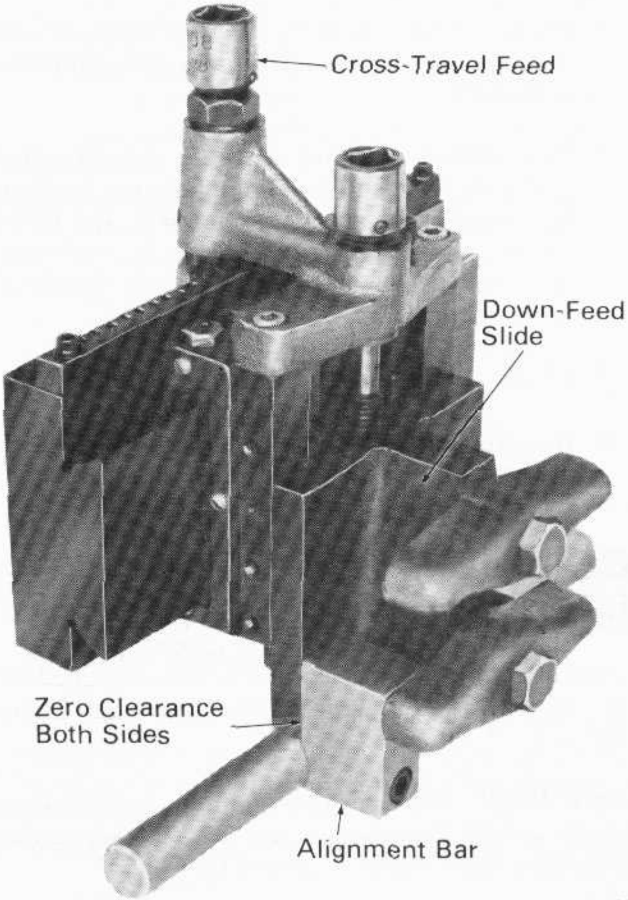

Fig.23 - Commutator Grinder Alignment Bar Installation

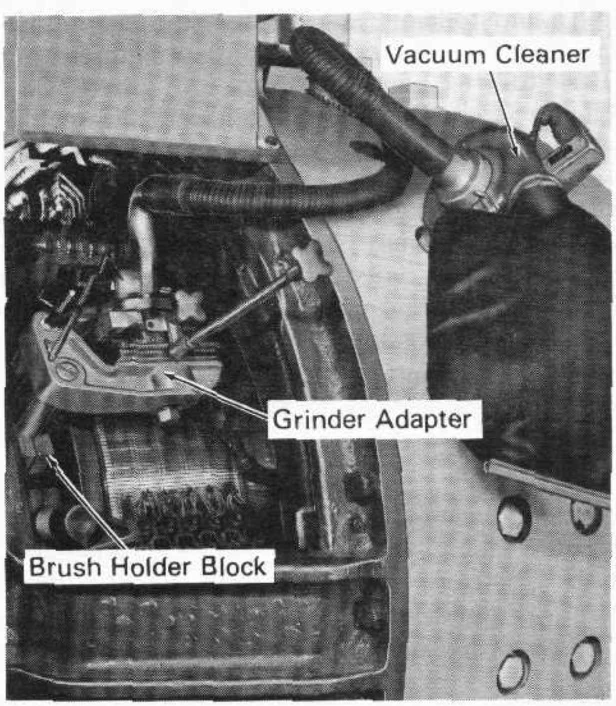

Fig.24 - Commutator Grinding Fixture Installation

movement across the commutator in either direction. Upon completion of the third pass, the stones can be fed down another 1/8 turn of the down-feed handle.

Alternating the end of the commutator from which the stones are fed down will minimize the possibility of the development of a taper across the commutator. Continue this procedure until all low areas have been completely eliminated.

NOTE

Feeding the grinding stone down more than 1/8 turn of the down-feed handle will result in very rapid wear of the grinding stones and also cause copper rollover on the trailing edge of the commutator bar. The copper rollover will have to be removed with the use of a de-burring tool. The recommended light feed will result in very small copper slivers on the trailing edge of the commutator bar which can easily be removed with a wire brush.

9. Remove the stones from the grinder and place them in their original box so that they will not become contaminated with oil or dirt. Remove the grinder and adapter.

10. With the armature rotating, clean the outer end of the commutator bars with a small piece of grinding stone.

11. Remove and discard the brushes used to start the diesel engine.

12. Thoroughly clean the generator to remove all copper and grinding dust by directing clean, dry compressed air at moderate pressure on the face of the commutator. Blow out brush holders, stator windings, and end housing. Rotate the armature by hand when blowing out commutator slots.

13. Remove the slivers of copper on the trailing edge of the commutator bar with a clean wire brush. Position the brush close to the commutator riser with the wire bristles toward the riser face and roll the wire bristles down toward the commutator slot until they enter the slot. Move the brush across the commutator until the wire bristles have cleared the end of the commutator slots. While moving the brush across the commutator, apply moderate pressure in towards the commutator as well as pressure towards the trailing edge of the commutator bar. This procedure will remove all copper slivers on the bar and in the slots without damaging the commutator surface.

NOTE

The scratch marks will disappear when the soft grade of chalk stone is used to finish the seating of the brushes.

14. When the depth of the mica undercut between copper bars is less than 1.2 mm (3/64″), use commutator slot file, Fig. 25, to undercut the mica to proper depth. Do not exceed the undercut maximum depth of 2 mm (5/64″).

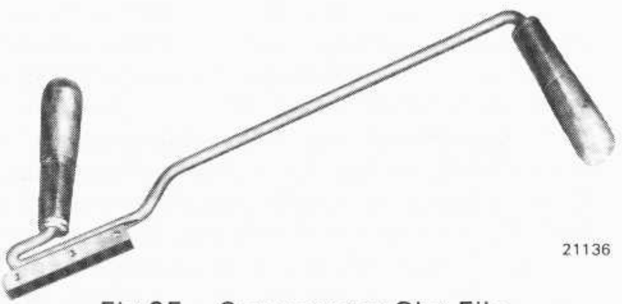

Fig.25 – Commutator Slot File

15. Use chalk stone for final clean up of commutator. Do not use emery cloth or sandpaper for this purpose. Lubricant should never be used on commutators, as brushes have enough graphite to supply their own lubrication.

16. Rotate armature by hand and blow clean dry air into the commutator slots to remove any loose pieces of copper. Wipe dirt and copper dust, away with clean cloths. Carefully inspect cleaning job and particularly the slots between commutator bars to see that all traces of undesired copper have been removed.

17. Replace brush holder assemblies and brushes. Install either new or the used brushes, but do not use any brush that had been left in the brush holder during the grinding operation. Reconnect cables.

18. Seat the brushes with the use of a fine grade sandpaper. Remove the sandpaper and start the diesel engine. Complete the seating of the brushes by using a seating stone as shown in Fig. 16. Refer to Service Data for seating stone part number. A 90% seat is satisfactory.

19. Clean the commutator with the use of clean dry compressed air.

COMMUTATOR TURNING

If the commutator is damaged to such an extent that grinding the commutator is not effective, the generator armature will have to be removed and the commutator turned in a lathe.

1. Place a suitable covering over the armature end winding to prevent chips from working into the armature.

2. The commutator must be turned just enough to give a uniform surface. For a light machine cut the speed of the armature should be 181 RPM or 504 meters per minute (1654 feet per minute). A carboloy-tipped lathe cutting tool should be used when making a light cut.

3. Finish commutator with fine grinding stones.

4. Round off ends of the commutator segments to at least a 2 mm (1/16″) radius with a fine mill file.

COMMUTATOR WEAR LIMITS

Overall Diameter – The commutator is designed for 10 mm (3/8″) radial wear which allows a minimum diameter of 870 mm (34-1/4″)

Neck Width – The face of the commutator is cleaned up by a light machine turned cut. The allowable minimum neck width is 19 mm (3/4″).

COMMUTATOR UNDERCUTTING

After the commutator has been turned and ground with a fine stone, the mica between the commutator bars should be undercut to a depth of 1 mm to 2 mm (3/64″ to 5/64″) and a width of 0.76 mm (0.030″). Refer to Service Data for tool number of undercutting saw.

After undercutting, de-burr the commutator with a hand scraper to remove sharp edges from commutator bars. Apply crocus cloth lightly around the commutator. Remove all copper cuttings and mica with clean dry compressed air.

GENERATOR DISASSEMBLY

NOTE

If equipment for disassembly and reassembly 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 generator-alternator is moved from its location, place strips of fish paper 2 mm x 80 mm x 900 mm (1/16″ x 3″ x 36″) in the bottom air gap between the armature assembly and stator coils.

When removing the generator, be sure to tag shims used under the mounting pads so they may be replaced in their original position.

If the generator does not have an attached alternator and therefore no collector ring assembly, perform only Steps 7 through 19.

Mount the generator on a sturdy stand at a suitable height. Use anchor shackle and base fixture for lifting complete generator assembly.

Refer to Fig. 26 during this procedure.

1. Remove collector ring cover, Fig. 27.

NOTE
On older units equipped with a compressor coupling, remove compressor guard.

2. Remove brushes from collector ring brush holders and remove brush holder cable connections. Remove brush holders.

3. Remove field lead connections from terminal posts of collector ring assembly.

4. Remove shaft flange and conduit bushing from end of shaft.

5. Place an extension cup around field leads and bolt extension cup to shaft as shown in Fig. 28.

NOTE
On older units with compressor coupling, compressor coupling must be removed with the collector ring.

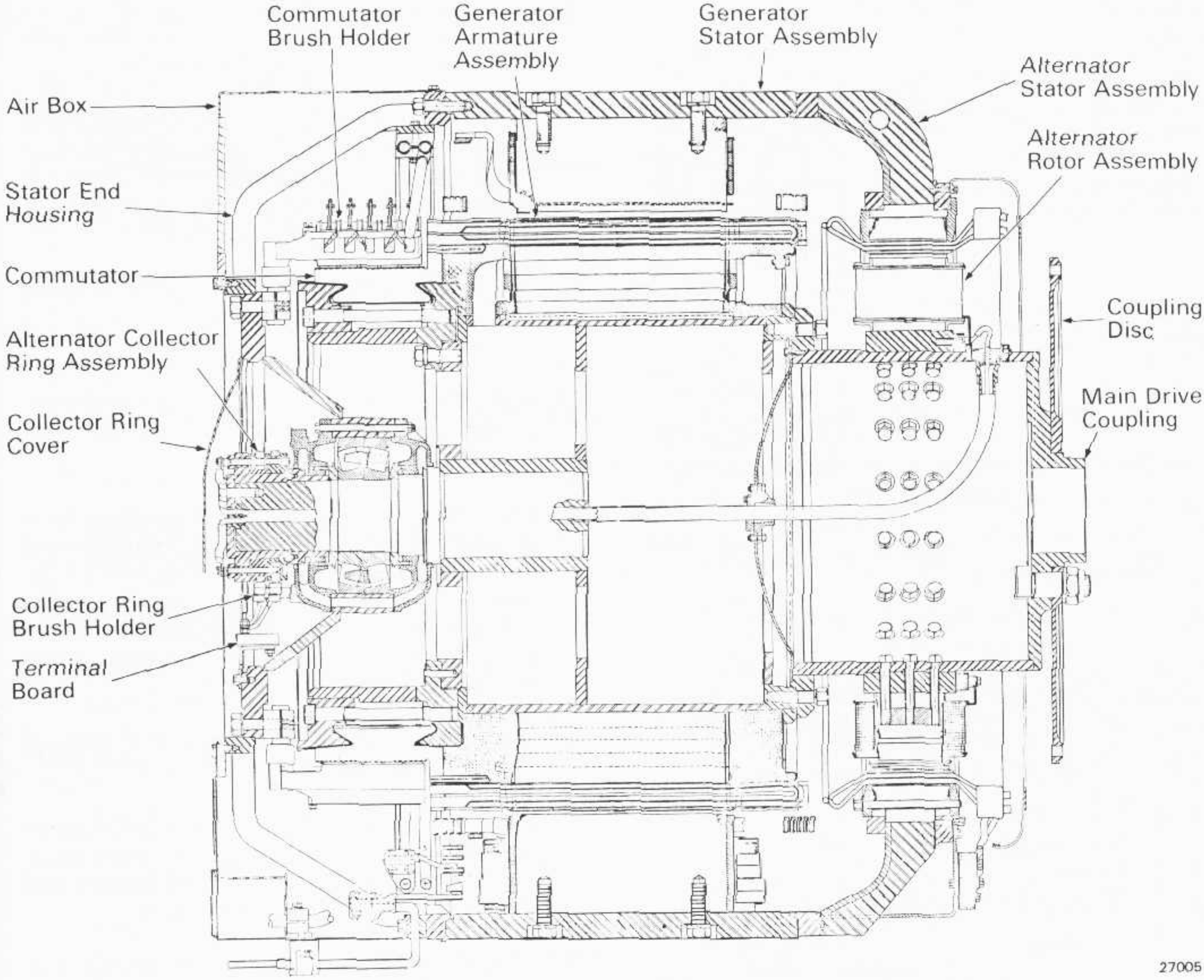

Fig.26 – D32-D14 Generator – Alternator Assembly, Cross-Section

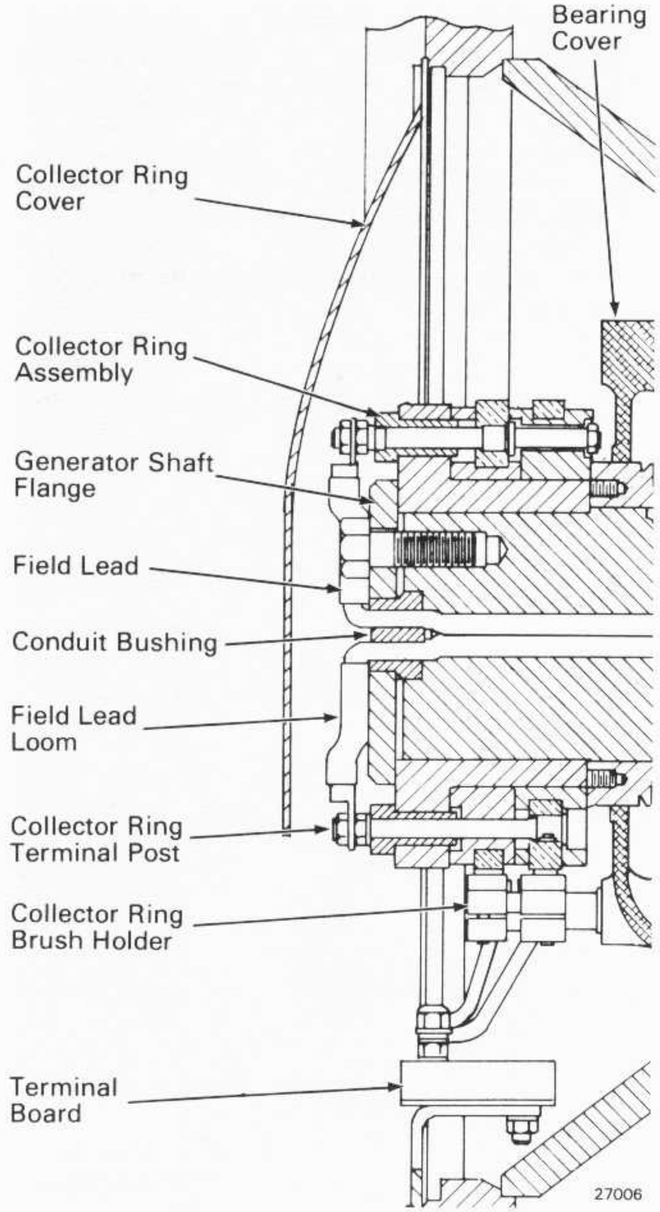

Fig.27 – Alternator Collector Ring Assembly, Cross-Section

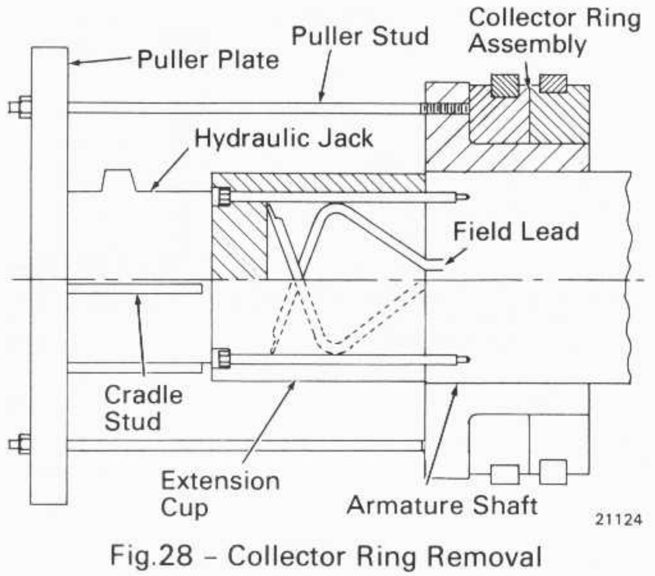

Fig.28 – Collector Ring Removal

6. Install a puller plate and puller studs to remove collector ring as shown in Fig. 28. Place a hydraulic jack between extension cup and puller plate, supported by cradle studs of puller plate. Remove collector ring using hydraulic jack.
7. Remove commutator covers and air box.
8. Remove brushes from commutator brush holders. Place a ring of fish paper around the commutator for protection.
9. Remove insulation wrapping from bolted connections of bus bars. Remove bolts from bus bars. Remove cleats and straps from bars and remove bus bars.
10. Support end housing with a wire cable and a crane and remove bolts holding end housing to stator.
11. Insert three 3/4″-10 jack bolts equally spaced around the end housing. Turn jack bolts until end housing is separated from stator.
12. Remove coupling disc. Observe coupling disc position in relation to the main drive coupling. Each is stamped with the armature number in the same position to ensure coupling disc will be assembled in its original position.
13. Apply arbor fixture to bore of main drive coupling and attach a wire cable to arbor fixture.
14. Raise the arbor fixture with a second crane until the air gap is equal around the circumference of the armature.
15. Carefully remove the armature assembly from the stator, Fig. 29, moving the armature toward the commutator end of the generator until the armature clears the stator assembly and can be rested on a cradle, Fig. 30. Ensure stand is high enough from the floor to clear the connections on the end housing.
16. Apply studs and puller plate and remove armature shaft sleeve.
17. Remove bolts from bearing cover and remove bearing cover. It may be necessary to tap cover with a rawhide mallet or soft wood hammer and gently pry with a pry bar to remove.
18. Remove stator end housing from bearing. Use care in easing bearing housing off the outer bearing race.

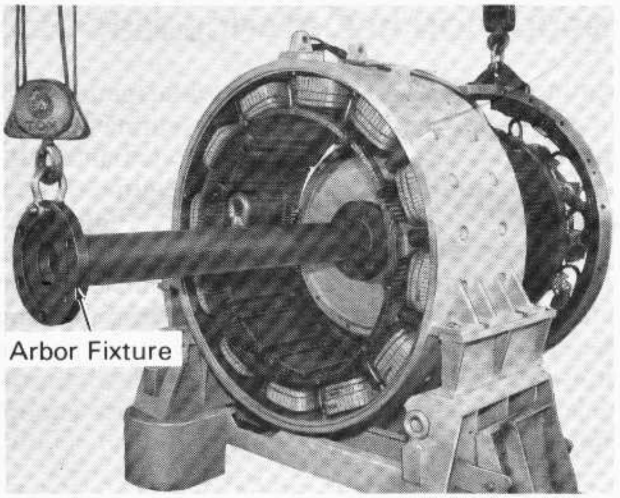

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Fig.29 – Removing Armature Assembly From Stator

NOTE
Arbor fixture and end housing are removed from armature assembly.

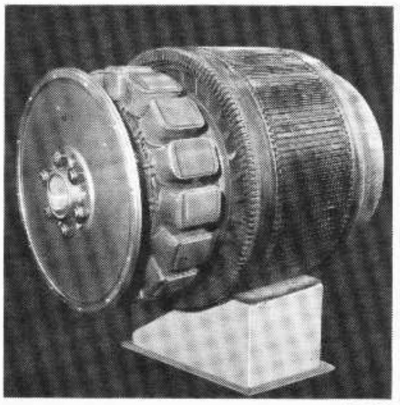

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Fig.30 – Armature Assembly Removed From Stator

19. To remove the remainder of the bearing assembly, insert eight 1/2"-20 N.F. Class 3 bolts into the spline nuts which are pressed into the bearing cap. With the use of a pulling plate, Fig. 31, or a hydraulic puller, remove the inner oil thrower, the bearing, outer oil thrower, and bearing cap. All eight studs must be used when studs are applied to the bearing cap to prevent breaking the bearing cap.

REMOVING ALTERNATOR STATOR (GENERATOR-ALTERNATOR UNIT ONLY)

For maintenance of the D14 alternator stator, refer to Maintenance Instruction M.I. 3306. For maintenance of the D18 alternator stator, refer to Maintenance Instruction M.I. 3307.

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

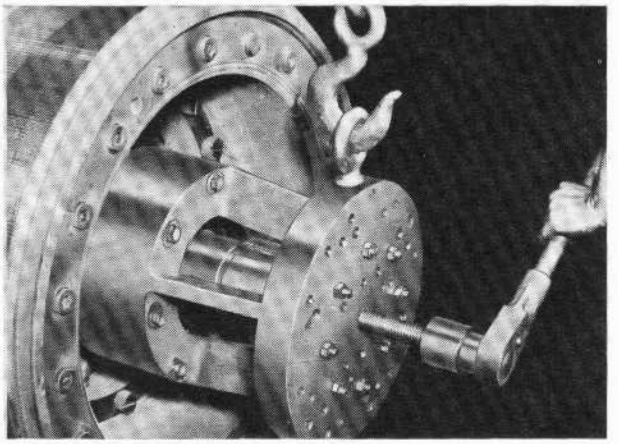

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Fig.31 – Generator Bearing Puller Plate

1. Remove alternator stator closure assembly, if required.
2. Properly support alternator stator. If the unit has ventilating openings around the stator frame, place a steel cable through the top two ventilating openings. Support the alternator with a suitable crane, but do not apply too much tension as some stator frames are constructed of cast aluminum and could crack.
3. Remove 3/4"-10 bolts holding alternator stator frame to generator frame.
4. Install three 1/2"-13 jacking bolts in the tapped holes provided in the alternator stator frame. Rotate jacking bolts evenly, taking care to avoid binding.
5. Remove alternator stator.

REMOVING ALTERNATOR ROTOR (GENERATOR-ALTERNATOR UNIT ONLY)

For maintenance of the D14 alternator rotor, refer to Maintenance Instruction M.I. 3306. For maintenance of the D18 alternator rotor, refer to Maintenance Instruction M.I. 3307.

To remove the alternator rotor from the generator armature, proceed as follows:

1. Support alternator rotor using a rotor lifting sling as shown in Fig. 32. Refer to Service Data for file number of sling.

NOTE
Ensure leads to the rotor field at the collector ring terminal posts are disconnected.

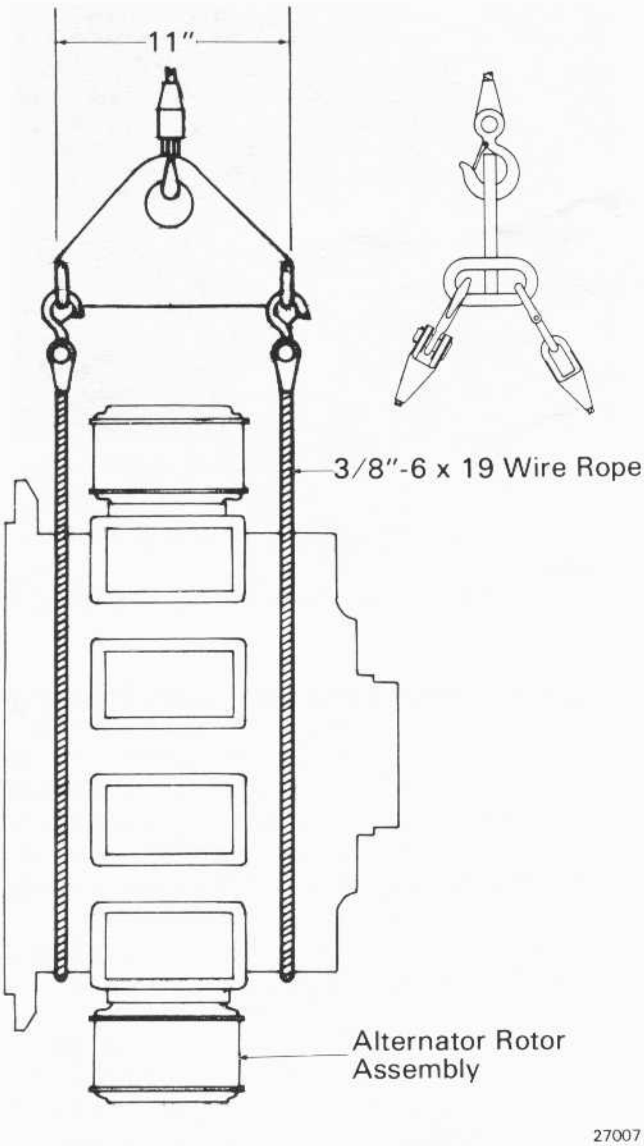

Fig.32 – Alternator Rotor Support

2. Remove 7/8"-9 bolts holding alternator rotor to generator armature.

3. Install two 3/4"-10 jacking bolts in holes provided in the alternator spider. Rotate the jacking bolts evenly to avoid binding. Remove alternator rotor.

STATOR INSPECTION AND REPAIR

INSULATION RESISTANCE AND HIGH POTENTIAL TEST

A stator with no known defects should have an insulation resistance and high potential test to qualify the stator for continued processing. Refer to Figs. 2, 3, or 4 as applicable.

INSULATION RESISTANCE TEST

An insulation and resistance test is suggested prior to the high potential test to determine that the insulation is satisfactory for high potential test. An accumulation of dirt and moisture sometimes is sufficient to cause leakage and, if high potential is applied, could cause an actual breakdown of the insulation. If the generator has been outside during cold weather and brought inside a warm building, the generator will tend to sweat and the condensed moisture will increase the leakage effect. Ensure generator is either stored inside or allowed enough time inside to dry.

Using a 250 to 1000 volt megger, perform an insulation resistance test as follows:

Stator low voltage circuits – 3 megohm minimum

Stator high voltage circuits – 5 megohm minimum

HIGH POTENTIAL TEST

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.

3. Perform high potential test as follows:

   Ground low voltage circuits before making high potential test on high voltage circuits.

   Apply a 1600 volt high potential test to stator for one minute at room temperature.

CLEANING

The extent of stator cleaning required is determined by the operation and service to which the generator is subjected. When the generator armature assembly is removed from the stator it is advisable to thoroughly clean the stator. The stator should be cleaned to remove all carbon dust, grease, and dirt.

One satisfactory method of cleaning and degreasing the stator is by granulated corn cob material applied with a controlled air blast. This method produces a clean, bright, oil free surface suitable for immediate varnish treatment.

When using the granulated corn cob air blast method, care should be exercised as it is possible to remove varnish and cut into the layers of insulation by prolonged application of the blast material. The pressures used with this method of cleaning should be from 300 to 400 kPa (45 to 60 psi).

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

If air blast equipment is not available, or if it is determined that the stator does not require extensive cleaning, refer to Generator Cleaning paragraph of this instruction.

If a solvent is used to clean the stator assembly, the stator assembly should be throughly dried out by placing the stator assembly in a convection-type oven and baked at 115°-125° C (239°-257°F) for 3 to 6 hours.

MAIN FIELD AND INTERPOLE COIL AND POLE INSPECTION AND REPAIR

Inspect the condition of the main field and interpole coils for charred or damaged insulation, or rubbed or deformed pole faces.

Overheating of field coils may result from a partial short circuit or a short in one of the field coils.

Removal of field pole cores from the field assemblies is not recommended. Loose poles should be tightened and loose ties must be replaced.

Pole pieces with a rubbed or deformed face should be replaced with a new or reconditioned pole. Main pole and interpole assemblies are only serviced as complete units.

Before removing any field poles from the stator assembly, obtain a measurement with an inside micrometer, from pole face of pole to be removed, to the diametrically opposite pole face. Record this measurement. Obtain a pole spacing measurement between the side of the main pole core and the side of the adjacent interpole cores, and record this measurement. These measurements are used for aligning new poles. Ensure there is no excess varnish at points of measurements.

Field poles or interpoles should be removed as a complete assembly, and the defective assemblies should be returned to Electro-Motive.

When replacing field poles, line up pole washer and spring assembly before tightening the pole bolts. Reassemble all interpole shims in their original position.

Before soldering or brazing connector straps or cable connections, align the pole spacing as follows:

1. The pole spacing between the side of the interpole core and the adjacent sides of the main pole cores has a nominal spacing of 36 mm (1-27/64″). The total variation between these spacings shall not exceed 1.27 mm (0.050″).

2. Every interpole air gap on any one generator shall be within 0.25 mm (±0.010″) of the average interpole air gap of that generator.

3. The spacing from the centerline of one main pole to the centerline of the adjacent main pole shall not vary from a nominal centerline by more than 0.8 mm (1/32″).

MODELS D12 AND D22 CABLE AND CONNECTION JOINTS

Models D12 and D22 generator stators, Fig. 33, have the following connections. Refer to Service Data for part numbers. Refer to Fig. 34 for main field coil locations. Refer to Fig. 2 Wiring Diagram.

1. Battery field and compensating field connections are soldered with tin base solder.

2. Shunt field coil lead connections are pressure applied crimp-type connections.

3. Interpole connector joints are brazed with brazing tongs and Sil-Fos solder.

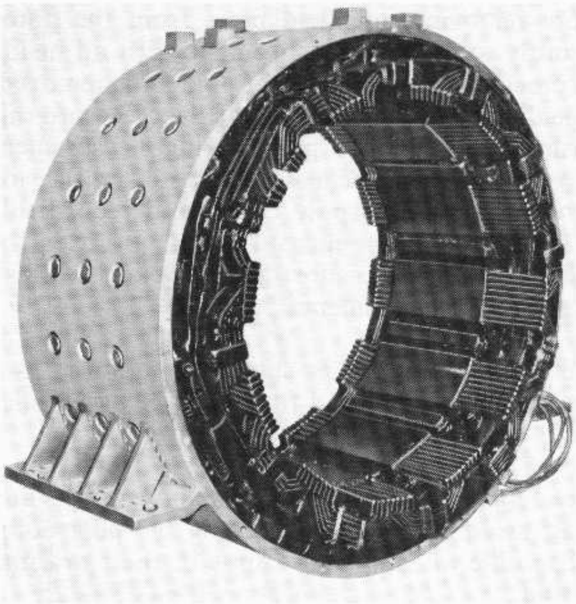
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Fig.33 - D12 And D22 Generator Field Assembly

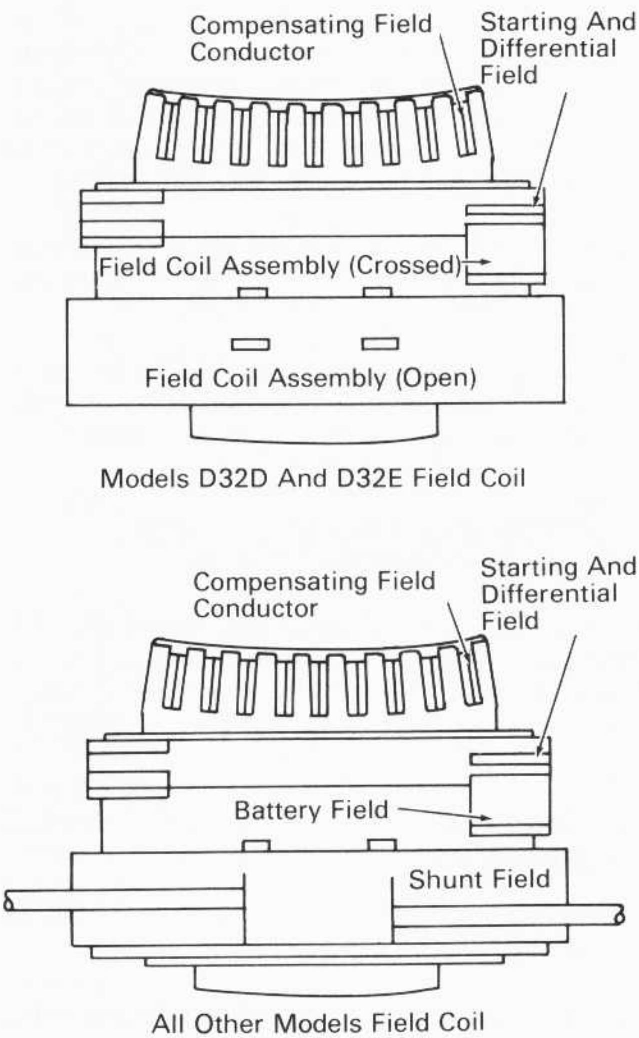

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Fig.34 - Main Pole Field Coil Locations

4. All other cable and connection joints are soldered with Hi-Temp solder.

Ensure solder does not run down the field conductors when performing any of the soldering operations.

MODEL D32 CABLE AND CONNECTION JOINTS

Model D32 generator stator, Fig. 35, has the following connections. Refer to Service Data for solder part numbers. Refer to Fig. 34 for main field coil locations. Refer to Figs 3 or 4 Wiring Diagrams as applicable.

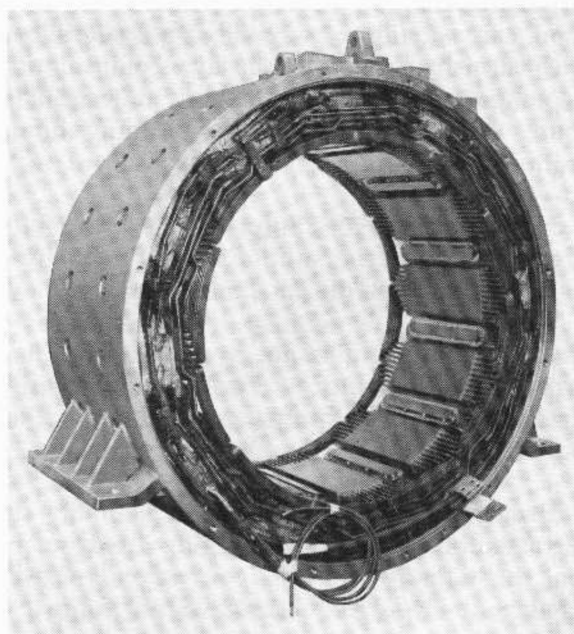
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Fig.35 - D32 Generator Field Assembly

1. Shunt field coil lead connections are pressure applied crimp-type connections.

2. Battery field connections are soldered with tin base solder.

3. Starting field, differential field, and compensating field connections are soldered with Sil-Fos solder.

4. Separately excited field (Model D32D and D32E only) are soldered using a solder piece between the leads. Bring the joint up to temperature once. Do not use solder rod unless absolutely necessary.

5. All other cable and connection joints are brazed.

Ensure solder does not run down the field conductors when performing any of the soldering operations.

NOTE

Due to special tooling required for brazing operations, it is recommended that D32 generators which require extensive stator repair be returned to Electro-Motive for overhaul.

INSULATION OF CONNECTIONS

Connections, straps, and cable leads to coils should be inspected to determine if they are properly insulated and secured. Refer to Fig. 34 for main pole coil locations.

The following insulation is required on the connections:

Shunt field connections –

2 layers of vinyl tape one-half lapped
2 layers of glass adhesive tape one-half lapped

Battery field connections –

2 layers of vinyl tape one-half lapped
2 layers of glass adhesive tape one-half lapped

Starting and differential field connectors –

Painted with red air-drying enamel

Brazed interpole connections –

2 layers of vinyl tape one-half lapped
2 layers of glass adhesive tape one-half lapped

All loose lead connectors –

Tied with 2 mm (1/16″) torpedo twine. Paint with red air drying enamel

Fish paper insulators –

Tied-in where required. Paint with red air drying enamel

D32 compensating field connections, Fig. 36 –

Sprayed or painted with red air drying enamel

D22 compensating field connections, Fig. 37 –

Sprayed or painted with red air drying enamel Rubber damping strips between field connectors on both ends of the stator. Damping strips tied in place with two turns of treated glass tape.

D12 compensating field connections –

Sprayed or painted with red air drying enamel Rubber spacers between the compensating field connectors. Spacers tied in place with 2 mm (1/16″) torpedo twine.

Pole bolt holes above the horizontal centerline should have the gap in pole bolt lockwashers sealed with a small ball of caulking compound.

The frame and spaces around pole bolt holes should be painted with gray locomotive enamel.

VARNISH TREATMENT

After repair and assembly, the stator should be varnish treated. Varnish should be thinned to maintain viscosity at 350-400 seconds Ford Cup No. 4 at 21.1° C (70.2° F). Refer to Service Data for varnish and thinner information.

1. Preheat the stator assembly in a convection oven so that the average steel frame and copper component temperature is maintained at 130° C (266° F) for a minimum of 1 hour.

2. Remove the hot stator assembly from the oven and immerse the stator completely in the varnish for 5 minutes.

3. Remove the stator from the varnish and allow the excess varnish to drain from the assembly for 5 minutes.

4. Clean the varnish from the stator frame bore face.

5. Place the stator assembly back into the oven and bake for 30 minutes at an average copper and steel temperature of 130° C (266° F).

6. Repeat Steps 2, 3, and 4.

7. Place the stator assembly back into the oven and preheat until the average copper and steel temperature is 150° C (302° F). Bake stator assembly for 5 hours at 150° C ± 5° (302° F ± 9°).

8. Clean varnish off stator frame bore face, all tapped holes, and mounting pads.

HIGH POTENTIAL TEST, REWIRED STATOR

Perform high potential test to a rewired stator as follows. Refer to Figs. 2, 3, or 4 as applicable.

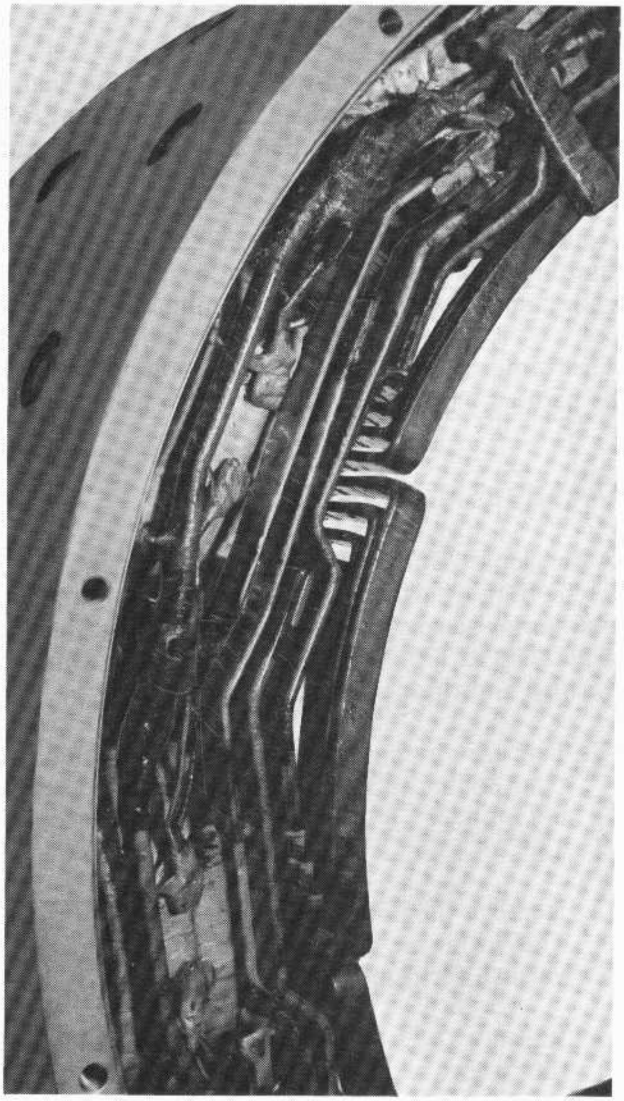

Fig.36 – D32 Compensating Field Connection

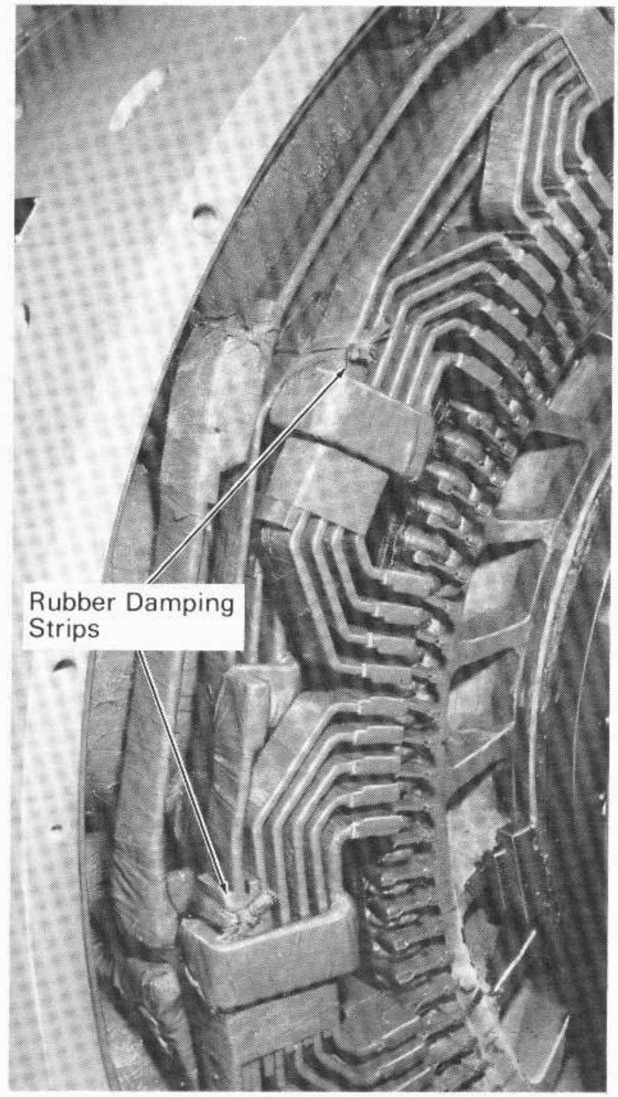

Fig.37 – D22 Compensating Field Connection

1. Ground both sides of the battery field circuit. Hi-pot main field and shunt field circuit at 4200 volts for 10 seconds. Remove ground from battery field circuit.

2. Ground both sides of the shunt field circuit. Hi-pot battery field circuit at 1200 volts for 10 seconds. Remove ground from shunt field circuit.

HIGH POTENTIAL TEST, REPAIRED STATOR (INCLUDING PARTIAL COIL REPLACEMENT)

Perform high potential test to a repaired stator at 50° C (122° F) as follows. Refer to Figs. 2, 3, or 4 as applicable.

1. Ground both sides of the battery field circuit. Hi-pot main field and shunt field circuits at 2400 volts for one minute. Remove ground from battery field circuit.

2. Ground both sides of the shunt field circuit. Hi-pot battery field circuit at 900 volts for one minute. Remove ground from shunt field circuit.

POLARITY TEST

If high potential test is satisfactory, polarity should be checked to determine that the coils are properly located in their magnetic position. Using low voltage DC power supply and a compass, check the polarity as follows:

1. Apply 15 volts to shunt or battery fields. Hold compass at center of the top main field coil. The compass should indicate a north or south pole reading. Move compass from pole to pole. Each

pole should indicate a definite change in polarity on the compass. If compass does not indicate a definite change in polarity, two poles of the same polarity are positioned next to each other or there is a wrong connection at the bus bars.

2. Apply 80 amperes DC to the starting, differential, and interpole fields. Check the interpoles in the same manner as the main poles.

3. If there is evidence of wrong polarity in either the main or interpoles circuits, the defective coils or connections will have to be corrected to obtain proper generator performance.

ARMATURE INSPECTION AND REPAIR

INSULATION RESISTANCE AND HIGH FREQUNCY TEST

An armature with no known defects should have an insulation resistance and high frequency test to qualify the armature for continued processing.

INSULATION AND RESISTANCE TEST

Perform an insulation and resistance test on the armature using a 250 to 1000 volt megger. If a megger indication of less than 3 megohms is found, bake armature for four hours at 110° C (230° F) in a convection type oven. Recheck armature megohm indication after cooling armature to room temperature. If the reading is still low, strip and rewind the armature.

HIGH FREQUENCY TEST

NOTE

The purpose of this test is to stress the insulation of the armature in a manner similar to actual operation of the generator. The insulation between turns, the insulation between the windings and the core should be simultaneously subjected to voltage (potential) stress.

A high frequency test can be performed which induces voltage to the armature coils electromagnetically. Because the armature winding is the equivalent of an inductance coil, this can be accomplished by impressing a high frequency voltage on the armature coils. Refer to Service Data for file number of a high frequency tester. Test the armature at 1800 volts. If a variation between high and low reading occurs that is greater than 10%, the armature is not acceptable. The minimum acceptable reading is 60 volts.

If armature fails on high frequency test and the failure is located in an upper coil, the upper coil can be raised and repaired, providing condition of the armature warrants this type of repair.

ARMATURE INSPECTION

The armature should be closely inspected for the condition of bands, wedges, coils, insulation, general assembly and commutator.

Armature bands and core wedges should be tight and secure. The soldering on the bands should be intact. If solder has been thrown off, the cause should be determined and corrected, and bands replaced. Unless proper facilities for banding are available, the generator should be returned to Electro-Motive.

The coil insulation should be clean and free from blisters, flakes, or cracks on the insulating varnish surface. When the condition of the insulating varnish on the armature requires treatment, and the proper facilities for vacuum impregnating are not available, return the generator to Electro-Motive.

If solder has been thrown out of the commutator risers, the armature may have to be rewound.

The surface of the commutator should present an even, smooth appearance, free from pitting. Under normal conditions where split type brushes are used, cleaning of the commutator with a cleaning stone should not be necessary.

If the commutator is etched, burned, or pitted to the extent that resurfacing is required, grinding will be necessary. Refer to Commutator section of this instruction.

CLEANING

The extent of armature cleaning required is determined by the operation and service the generator has been subjected. When the armature assembly is removed from the stator, it is advisable *to throughly clean the armature. The armature* should be cleaned to remove all carbon dust, grease, and dirt.

One satisfactory method of cleaning and degreasing the armature is by granulated corn cob material applied with a controlled air blast. This method produces a clean, bright, oil free surface for immediate varnish treatment.

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

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

If air blast equipment is not available or if it is determined that the armature does not require extensive cleaning, refer to Generator Cleaning paragraph of this instruction.

If a solvent is used to clean the armature assembly, the armature assembly should be thoroughly dried out by placing the assembly in a convection-type oven and baked at 115°-125° C (239°-257° F) for 3 to 6 hours.

VACUUM IMPREGNATING ARMATURE ASSEMBLY

Armatures which pass the insulation resistance and hi-pot test should be varnish treated. Varnish should be thinned to maintain Ford cup No. 4 orifice viscosity at 250-325 seconds at 21.1° C (70° F). Refer to Service Data for varnish and thinner information.

Perform vacuum impregnation of armature assembly as follows:

1. Clean armature core section thoroughly with Xylol or petroleum solvent and wipe dry with clean dry cloths.
2. Preheat armature in a convection oven so that the average armature core temperature stabilizes at 120° C +5° -10° C (248° F +9° -18° F). Ensure core temperature does not exceed 125° C (257° F).

NOTE

Armature core temperature must be between 110°-120° C (230°-248° F) for impregnation cycle. If armature is overheated, allow to cool until the desired temperature of 120° C (248° F) is reached.

3. Remove armature from oven and place in vacuum impregnation tank. Do not allow armature core to cool below 110° C (230° F) before placing in tank.
4. Apply 710-760 mm (28″-30″) vacuum to tank for 15 minutes.
5. With vacuum still on tank, run varnish into tank to level of commutator risers. Break down foam by occasionally injecting small amounts of CO^2 into impregnating tank as varnish rises around armature. If the vacuum is not sufficient to draw varnish up to the required level, CO^2 may be injected into the tank to force the varnish up to the desired level. Do not open release valve to admit atmospheric air into the impregnating tank.
6. Reduce vacuum to zero with CO^2 additions. Check that varnish is at proper level, then increase CO^2 pressure to 200-275 kPa (30-40 psi). Allow armature to remain under pressure for a minimum of 15 minutes to a maximum of 20 minutes.
7. Reduce CO^2 pressure to 70-100 kPa (10-15 psi) by opening the vacuum valve. Do not open release valve to atmospheric air. Empty varnish from impregnating tank using the 70-100 kPa (10-15 psi) CO^2 pressure.
8. Immediately pull vacuum on impregnating tank by opening the vacuum valve. Hold 710-760 mm (28″-30″) vacuum for 30 minutes (pressure must be corrected to sea level).
9. Remove armature from impregnation tank and wash varnish from shaft, and commutator face and risers with a rag saturated with petroleum solvent.
10. Place armature in a convection oven.

NOTE

Bake cycle should start within 15 minutes after completion of impregnation cycle.

11. Attach thermocouple to armature commutator. Bake armature 9 hours after average core temperature reaches 155° C (311° F). Ensure commutator temperature does not exceed 155° C.
12. Remove armature from oven.

NOTE

While stator is still hot (50° ± 10° C [122° ± 18° F]), perform high potential test which follows.

HIGH POTENTIAL TEST, REWOUND ARMATURE

While armature is still hot (50° ± 10° C [122° ± 18° F]), hi-pot at 32 volts to ground for 60 seconds.

HIGH POTENTIAL TEST, REPAIRED ARMATURE

While armature is still hot (50° ± 10° C [122° ± 18° F]), hi-pot at 2400 volts to ground for 60 seconds.

HIGH FREQUENCY TEST, REWOUND ARMATURE

Refer to High Frequency Test paragraphs at beginning of this armature section.

Test armature at 3500 volts. If a variation between high and low reading occurs that is greater than 10%, the armature is not acceptable. The minimum acceptable reading is 150 volts.

HIGH FREQUENCY TEST, REPAIRED ARMATURE

Refer to High Frequency Test paragraphs at beginning of this Armature section.

Test armature at 1800 volts. If a variation between high and low reading occurs that is greater than 10%, the armature is not acceptable. The minimum acceptable reading is 60 volts.

ARMATURE SHAFT

DIMENSIONS

Refer to Fig. 38 for production dimension tolerances of the armature shaft seats.

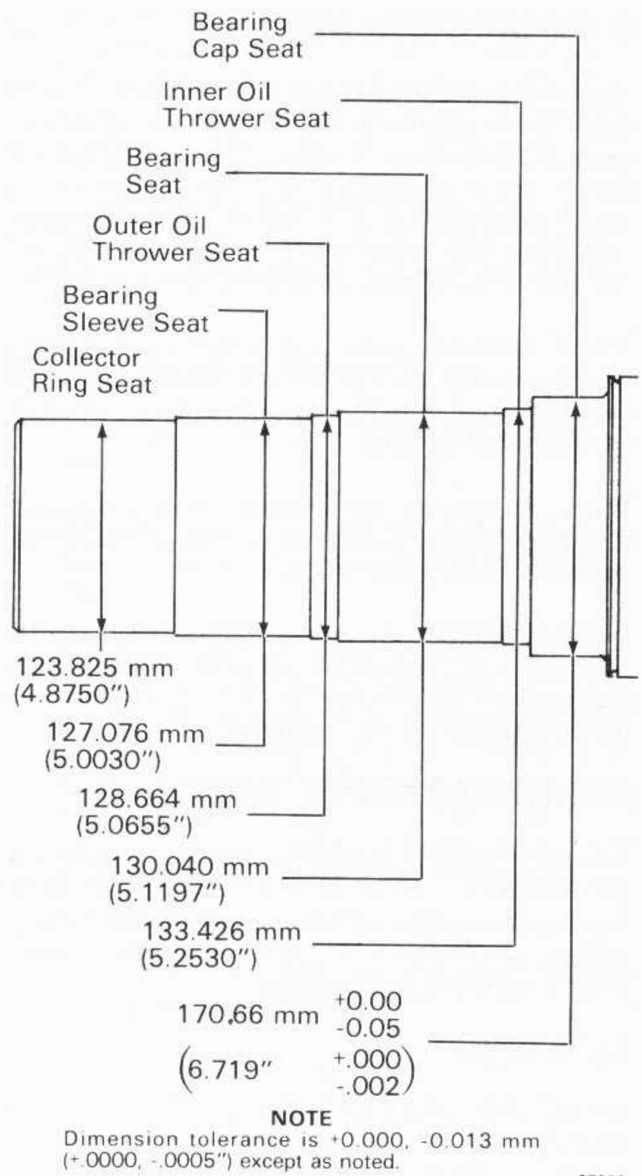

Fig.38 - Armature Shaft Dimensions, Production Tolerances

MAGNETIC PARTICLE INSPECTION

A magnetic particle inspection should be performed to qualify the shaft for reuse. Ensure the shaft is clean and free of all rust and oil.

The shaft must be magnetized to perform a magnetic particle inspection, but the shaft may retain enough residual magnetism to check. Check the shaft for residual magnetism by one of the following two methods:

1. Apply magnetic powder to the end of shaft. The powder should adhere. If it does not adhere, it will be necessary to magnetize the shaft.
2. Suspend a short length of iron or steel wire at the end of a piece of string near the end of the shaft. Observe any attraction of the wire to the shaft. If no attraction is observed, it will be necessary to magnetize the shaft.

NOTE

If there is any doubt as to the shaft being sufficiently magnetized, the shaft should be magnetized.

The shaft can be magnetized by using a unit capable of producing 500 to 700 amperes of alternating current and wrapping three turns of No. 0000 flexible cable around the ends of the shaft.

Apply current to the cable turns to magnetize the shaft.

After it is determined that shaft is magnetized, apply magnetic powder sparingly to the machined surfaces. Any cracks or defects are cause for rejection.

DYNAMIC BALANCING

The generator armature and the alternator rotor are dynamically balanced individually (the alternator rotor at 500 RPM and the generator armature at 375 RPM) and as a generator armature and alternator rotor assembly at 375 RPM. After dynamic balancing, the assembly is floated through and checked at the critical speed of balancing machine.

When balancing generator armature assembly, counterweights are added to the spider on the rear end of armature and to the inside diameter of the commutator "V" ring.

When balancing alternator rotor assembly, counterweights are added to each end of the inside diameter of the rotor spider.

When balancing generator armature and alternator rotor assembly, counterweights are added to outside diameter of the alternator rotor spider and the inside diameter of the commutator "V" ring.

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 inspections, a bearing must be throughly cleaned. Stoddards Solvent or similar noncorrosive solvent having a flash point of 46° C (115° F) or higher may be used. After inspection, bearing 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.

CAUTION

Adequate ventilation and safety precautions are necessary when handling inflammable fluids.

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 with a new bearing.

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 with a new bearing.

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 with a new bearing.

BEARING CAGES

Bearing cages which show excessive wear should be replaced with a new bearing.

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 stator end 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.

If a new bearing and housing are being used, it may be necessary to hone housing bore. The bearing must have a push-fit having clearance of 0.05 mm to 0.08 mm (.002" to .003"). Refer to Service Data for bearing dimensions and tolerances.

Refer to cross-section of generator-alternator, Fig. 26 during assembly procedure.

BEARING AND END HOUSING ASSEMBLY

1. Remove old grease from bearing cap and cover. Clean bearing cap and cover. Repaint with crankcase paint and allow to dry.
2. On older bearing caps and covers with labyrinth grooves, fill the labyrinth grooves with Unirex N-2 grease. This grease need not be measured.
3. Weigh the piece of paper that will be used in handling the grease to fill the cavity in the bearing cap and cover. The weight of the paper must be compensated for when weighing the grease.
4. Carefully weigh the grease for the bearing cap and cover cavity. Refer to Service Data for quantity.

CAUTION

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

5. Pack grease into the bearing cap and cover cavities. Leave a free space at the top of the bearing cap and cover to limit grease churning and liquefaction of the grease. Using a spatula or putty knife, roughly form the grease to desired contour as shown in Fig. 39, and apply grease mask. Refer to Service Data for grease mask part number. The grease cavity should be filled to complete an arc of 240° to 270°. The grease arc must be packed without air voids.

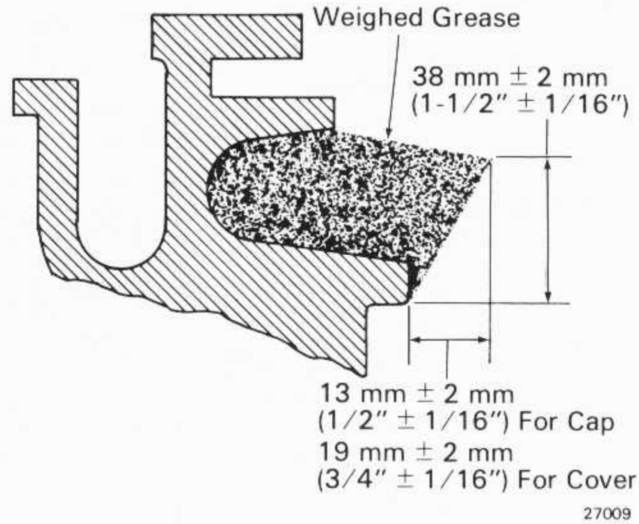

Fig.39 - Application Of Grease To Bearing Cap And Cover

6. Rotate grease mask to form proper contour, keeping grease mask seated. Several turns may be required to get proper contour. Use spatula or putty knife to fill low spots with grease from the grease mask blade. The small amount of grease retained on the blade should be removed and applied to the ends of the grease arc. The contour should be built up to the limits of Fig. 39.
7. Clean armature shaft and remove burrs or gall marks.
8. Place bearing cap on shaft. Ensure space free of grease is at the top of the bearing cap. Refer to Fig. 40 for bearing assembly cross-section.

CAUTION

Use care when heating bearing parts. Overheating may result in warping or damaging the metal.

9. Heat the inner oil thrower, outer oil thrower, and the shaft sleeve in an oil bath, electric oven, or induction heater to 120° C (248° F). If an oil bath is used for heating, remove oil with clean, bound-edge cloths prior to shrinking to shaft. When using induction heater, pyrometer readings (with heater current off) should be taken periodically.
10. After inner oil thrower is heated to proper temperature, shrink the inner oil thrower to the shaft. Refer to Fig. 40 for position. Allow inner oil thrower to cool to room temperature.
11. Pack the bearing rollers and the space between the two rows of rollers completely with the quantity of grease specified in the Service Data.

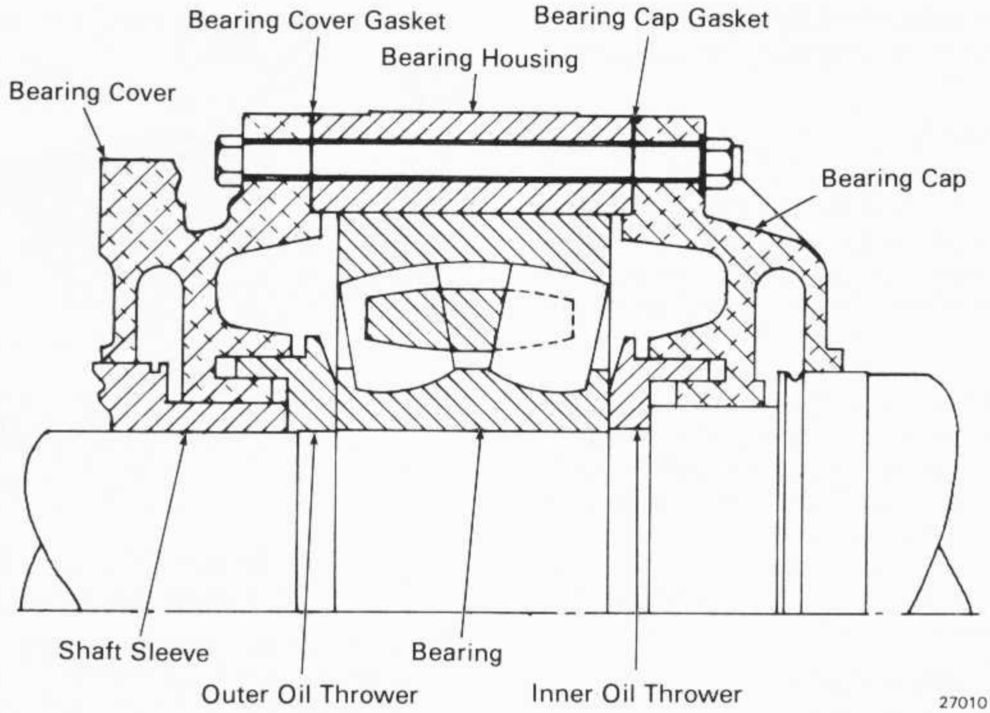

Fig.40 – Bearing Assembly, Cross-Section

12. Heat the roller bearing with an induction heater to 120° C (248° F). Take pyrometer readings (with the heater current off) at outside face of inner race only. Do not cock the bearing when placing it on the shaft. Use a brass pipe to push the bearing up to the inner oil thrower. Allow bearing to cool to room temperature.

13. Check the runout of the bearing inner race. Runout should be within 0.05 mm (.002″) total indicator reading.

14. After outer oil thrower is heated to proper temperature, remove from heating unit. If an oil bath is used for heating, remove oil from outer oil thrower with clean, bound-edge cloths prior to shrinking to the shaft. Shrink outer oil thrower to the shaft. Refer to Fig. 40 for position. Allow outer oil thrower to cool to room temperature.

15. Apply two 1/2″-20 UNC-2B aligning studs, 180° apart to the spline nuts pressed into the bearing cap, Fig. 41. These studs are required to guide the bearing housing to the bearing cap.

16. Install a new gasket to the bearing cap. Gasket must be lined up to clear bolt holes and may be held in place by applying a spot of grease to the gasket.

17. Apply Molykote to inside diameter of the bearing housing sleeve of the stator end 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.

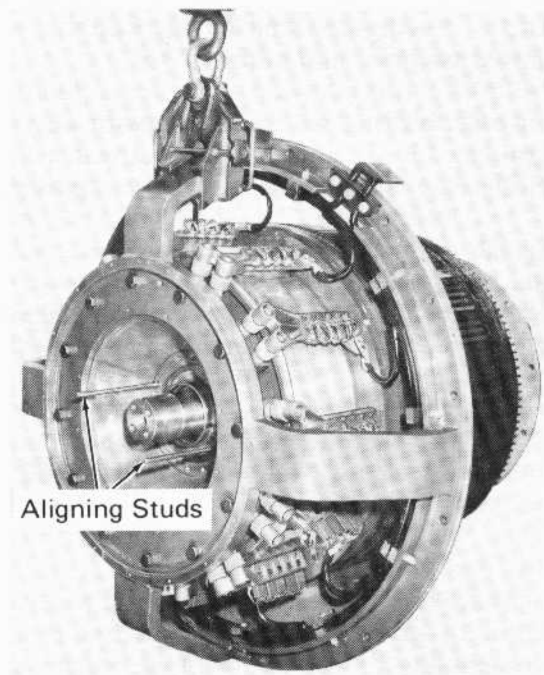

Fig.41 – Applying End Housing To Armature Assembly

18. Place alignment guide on shaft to hold the bearing outer race stationary and to assist in

placing the end housing over the roller bearing. Ensure grease grooves and holes in bearing and bearing housing are filled with grease. Install "DO NOT GREASE" metal tag with screws near top of cover. Refer to Service Data for part number of bearing alignment guide.

19. Lift the stator end housing and bearing housing as shown in Fig. 41. Align the bearing housing with the aligning studs. Push the end housing onto the shaft until the bearing housing is snug against the bearing cap. Ensure the housing drain is lined up with the cap drain.

20. Install the greased bearing cover with a new gasket. Ensure the space free of grease is at the top of the cover. Bolt the bearing cover to the end housing, lining up the cover drain hole with the housing drain hole.

21. Heat the armature shaft sleeve in an oil bath, electric oven, or induction heater to 127° C (260° F) and shrink to shaft. If oil bath is used for heating, remove oil from sleeve with clean, bound-edge cloths prior to shrinking to the shaft. When using induction heater, pyrometer readings (with heater current off) should be taken periodically.

22. On generator-alternator units, perform the following procedure:

    a. Place collector ring assembly in an oven and heat to 120° C (248° F). After heating, place collector ring assembly on shaft and hold in position until shrunk on shaft. Refer to Fig. 42.

    b. Install brush holder assemblies on posts pressed in bearing cover. Torque brush holder clamping bolts to 20-27 N·m (15-20 ft-lbs). Set brush holder assemblies so that a 3 mm (1/8") clearance is obtained between bottom of each brush holder and the collector ring, Fig. 43.

    c. Reconnect brush holder cable assemblies to brush holders.

NOTE

On older units with compressors, apply compressor coupling to collector ring and bolt in place.

23. Assemble conduit bushings on field cables and insert into end of shaft. Bolt shaft flange to end of shaft.

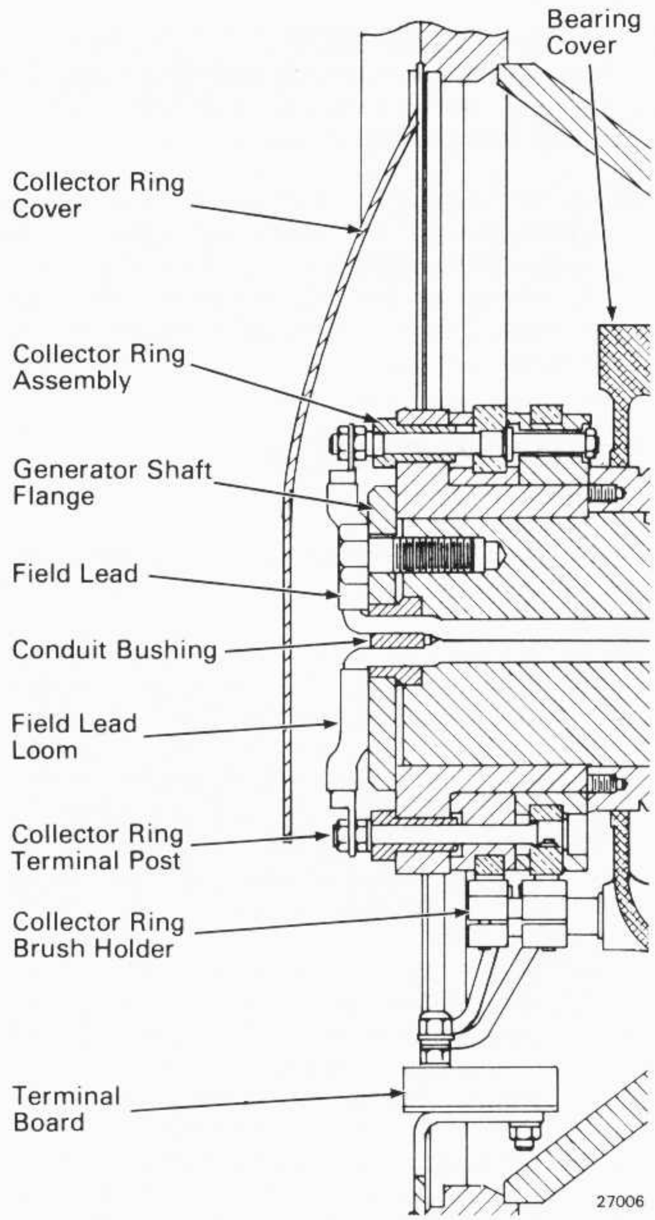

Fig.42 - Alternator Collector Ring Assembly Cross-Section

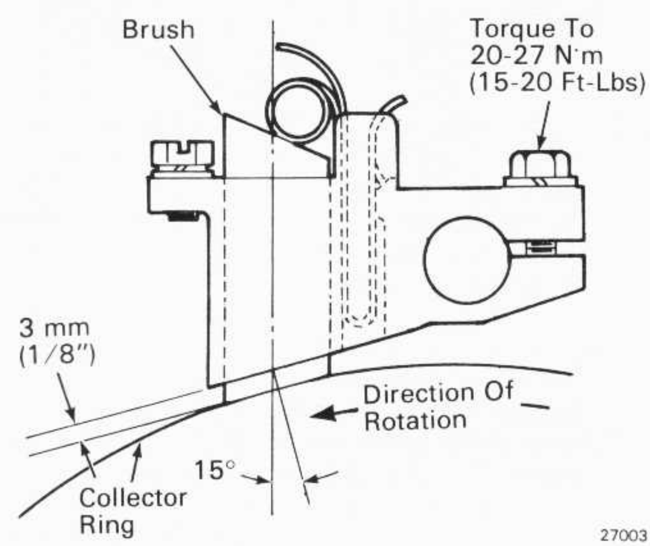

Fig.43 - Collector Ring Brush Holder Installation

NOTE

If new cables are used, cut and skin to allow enough slack in cables to clear bolt heads. Solder terminal lugs to cables.

24. Apply 16 mm (5/8") loom insulation over field cables and tie cables with torpedo twine. Apply cables with terminals to posts with brass studs. Cables are not marked for any particular post. Paint cables and loom with red air drying enamel.

ROTOR TO STATOR ASSEMBLY

1. On generator-alternator unit, perform the following procedures:

   a. If alternator rotor assembly was removed from the armature, bolt these two assemblies together using the 7/8"-9 bolts removed during disassembly, Fig. 44. Ensure the alternator rotor leads are threaded through the armature shaft. Torque bolts 508-542 N·m (375-400 ft-lbs) dry, or 475-508 N·m (350-375 ft-lbs) lubricated.

   b. If alternator stator was removed from generator frame, bolt these two assemblies together using the 3/4"-10 bolts removed during disassembly. Ensure correct holes in the ring line up with mating holes in the stator frame. The centerline of the 3/8"-16 NC tapped hole which is centered in a 76 mm (3") counterbore in the outer flange of the alternator stator, must line up with the centerline of the terminal board on the generator frame, Fig. 45. Torque bolts to 271 N·m (200 ft-lbs).

2. 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 alternator rotor, the end of the arbor fixture protrudes through the stator assembly as shown in Fig. 46.

3. Using two wire cable loops, place one loop through the end housing and the other loop through 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.Torque the bolts to 271 N·m (200 ft-lbs).

4. Place fish paper strips 2 mm x 80 mm x 900 mm (1/16" x 3" x 36") in air gap between rotor assembly and coils of the armature. Remove wire cable loops and arbor fixture after fish paper has been applied.

5. On generator-alternator unit, apply coupling disc to alternator rotor hub using six 1-1/2"-12 "D" head bolts removed at disassembly. Apply Texaco Threadtex lubricant to bolts, install hardened washers and self-locking nuts and torque to 2440 N·m (1800 ft-lbs).

NOTE

Any Model D12 or D22 generator using the old style nut and bolt should be torqued to 1627 N·m (1200 ft-lbs). If the self-locking nut is replacing the old style nut, the rotor hub diameter must be machined from 187 mm to 178 mm (7-3/8" to 7") to allow clearance for the new nut.

6. Install commutator brushes, and bolt shunts from brushes to brush holders. Ensure brushes are properly seated. Ensure there is no carbon dust on commutator risers, string band, or porcelain insulators.

7. Prior to assembly of bus bar, ensure bus bar is clean and free of burrs. Bolt the starting field connector bus bar to the starting bus. Bolt the generator negative bus bar to the generator negative bus. Bolt the brush holder negative bus bar to the bus which ties in the compensating and differential connections. After tightening all bolts connections, insulate connections with one layer of Empire cloth, one layer of vinyl tape one-half overlapped, and two layers of friction tape one-half overlapped. Paint the insulated connections with red air drying enamel.

8. Attach bus bar to generator frame by inserting molded cleat under bus bar. Refer to Service Data for part number. Place molded clamp over bus bar. Refer to Service Data for part number. Bolt assembly to generator frame.

NOTE

If old style clamp is used with wood block under bus bar, use phenolic block as insulator between bus bar and metal clamp. Refer to Service Data for part numbers.

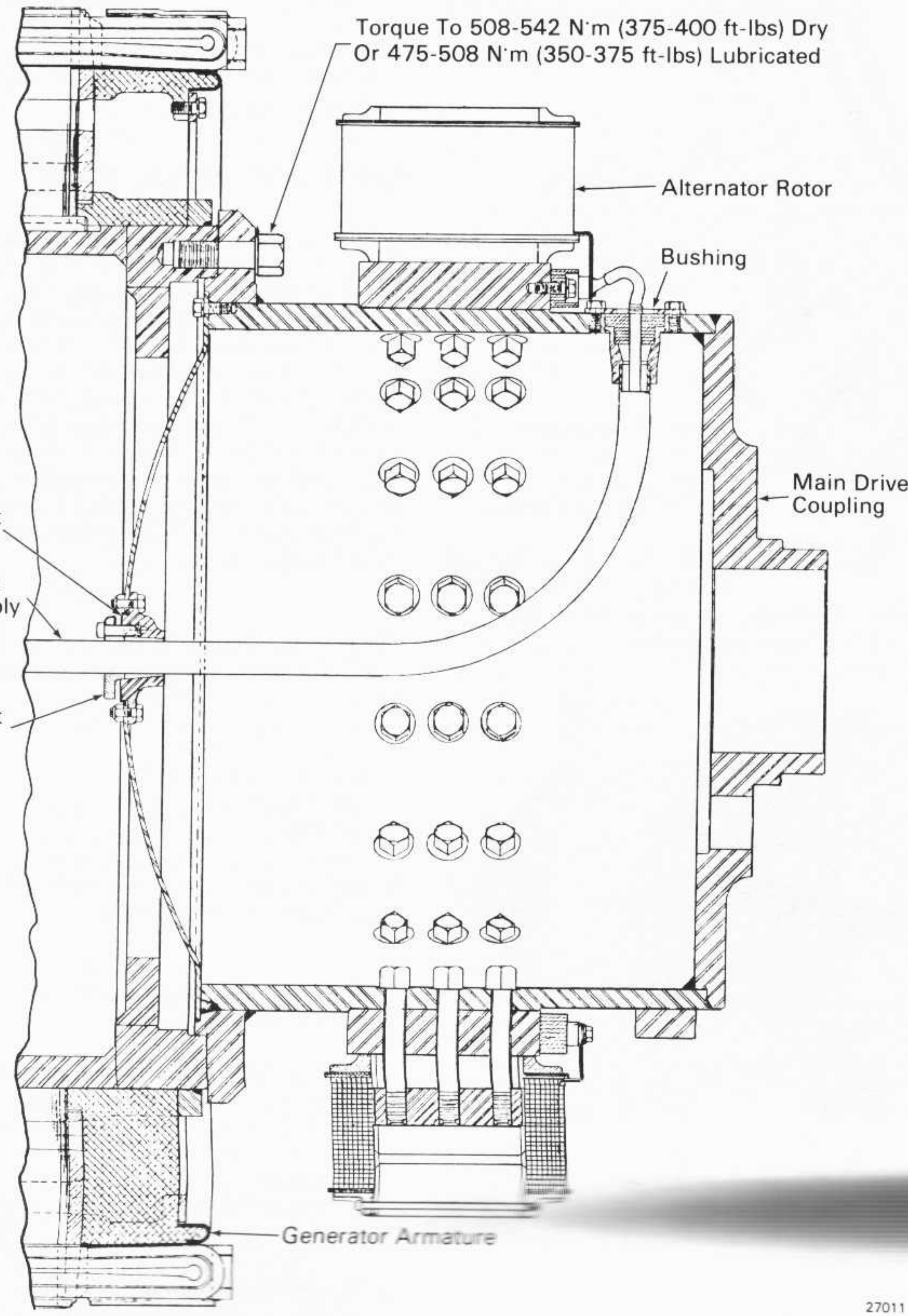

Fig.44 – Alternator Rotor Assembled To Generator Armature

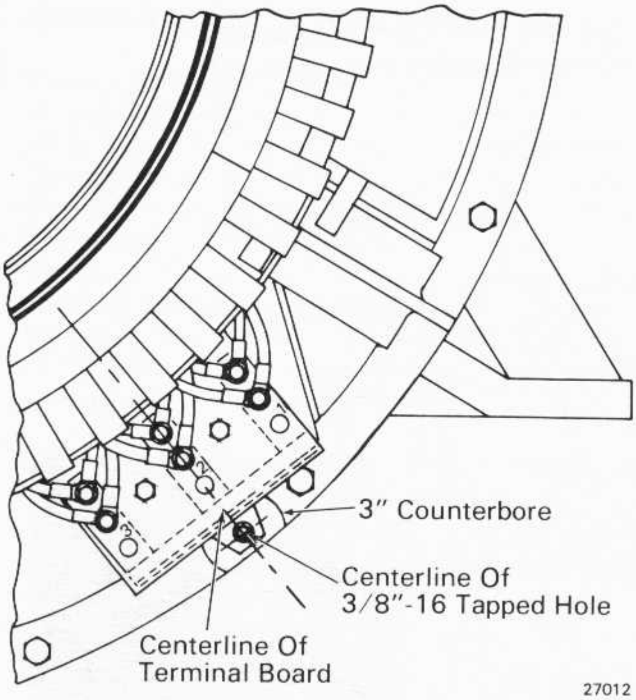

Fig.45 - Alternator Stator Position On Generator Frame

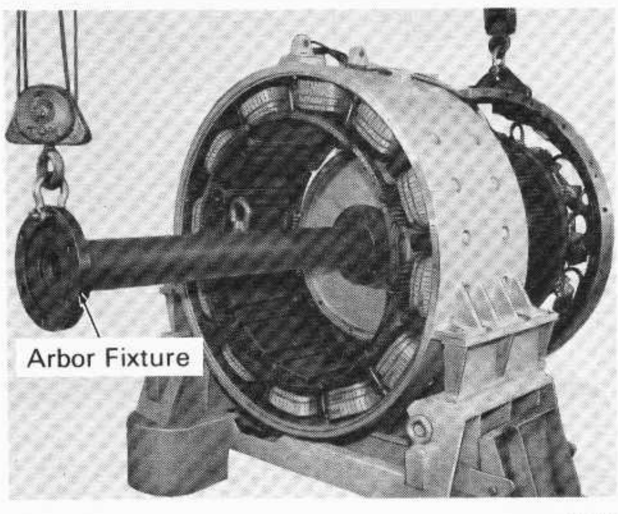

Fig.46 - Installing Armature Into Stator

9. Reassemble air box assembly and commutator covers.

CAUTION

In Step 10, connect the cable leads from brush holders of same polarity to the same terminal post, or the rotor field will be short circuited and a direct short circuit placed on the auxiliary generator.

10. On generator-alternator unit, connect collector ring brush holder cables to terminal block on guard assembly.

NOTE

On older units equipped with compressor coupling, assemble compressor coupling guard assembly.

HIGH POTENTIAL TEST

Before high potential tests are made, it is highly desirable to check first with a meghommeter. 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
AC circuits	400 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

BRUSH SETTING (KICK NEUTRAL)

To ensure proper operation of the generator, it is important that the brush setting is correct. When necessary, use the following procedure to check or set the brush position.

1. Check the brush holder angular spacing. Brush holders should be equally spaced around the commutator to within 0.4 mm (1/64″).
2. Mark one commutator bar as number one bar. Facing the commutator, and counting counter-clockwise, count 47 bars. This is called the span. Mark the center of the last bar in span (number 47).
3. Lift all brushes.
4. Connect a 6-volt storage battery and a switch in series with the generator field.
5. Connect a zero center reading (50 millivolt movement) ammeter across the first and last commutator bars in the span.
6. Read the armature kick voltage when the switch (connected in series with the field circuit) is opened and closed. Wait several seconds after the switch is closed so that the field current can build up.
7. Excite the field then rapidly open the field circuit. Note the deflection on the meter. Rotate the armature about one commutator bar distance and repeat. If the second indication is greater than the first, and of the same polarity, the armature was rotated in the wrong direction.

   If the second indication is of opposite polarity of the first indication, the neutral point has been passed. Repeat procedure of slightly rotating the armature until meter indication is zero or as near to zero as possible.
8. Rotate the end housing of the generator so that the centerline of commutator bar number one and bar 47 lie equidistant from the centerlines of the brushes of the adjacent brush holders.
9. Measure the distance of the centerline of all the brushes from the center of each 46th bar, and average.
10. [illegible]

INSTALLATION OF GENERATOR INTO LOCOMOTIVE UNIT

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

Before a generator is installed, check and clean the mounting plates. Ensure 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. Ensure 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 lubricating 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 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 stator coils.

Line up dowel holes and base bolt holes and insert base bolts. Do not insert [illegible]

SERVICE DATA

SPECIFICATIONS

WEIGHTS

Generator/Alternator (Complete)	7 307 kg (16,110 lbs)
Generator Armature	2 640 kg (5,820 lbs)
Generator Stator	3 538 kg (7,800 lbs)
Alternator Rotor	626 kg (1,380 lbs)
Alternator Stator	503 kg (1,110 lbs)

AIR GAP (Nominal)

Main Poles	3.899 mm (0.1535″)
Interpoles	8.33 mm (0.328″)

BRUSH HOLDERS

Number Of Brush Holders	12
Clearance – bottom of brush holder to commutator	3 mm + 1.5 mm - 0.00 mm (1/8″ + 1/16″ - 0″)

BRUSH HOLDERS

D12, D22, Current D32 (After June of 1982)
Adjustable 8084210

Former D32 (Prior to June of 1982)
Constant Pressure 8331071

BRUSHES

D12, D22, Current D32 (After June of 1982) – Brush Holder 8084210

Brush Type	Brush Grade	Part Number
Two Wafer	DE8	8307806
Two Wafer	AC127	9334438

Size Of Brush (Long Side)

65 mm x 33 mm x 16 mm (8 mm - 8 mm)
(2-9/16″ x 1-5/16″ x 5/8″ [5/16″ - 5/16″])

D32 (Prior to June of 1982) – Brush Holder 8331071

Brush Type	Brush Grade	Part Number
Two Wafer	DE8	8330994
Two Wafer	AC127	9334437

Size Of Brush (Long Side)

65 mm x 33 mm x 21.4 mm (10.7 mm - 10.7 mm)
(2-9/16″ x 1-5/16″ x 27/32″ [27/64″ - 27/64″])

D32 (Prior to June of 1982) Padded Replacement Brush – Brush Holder 8331071

Brush Type	Brush Grade	Part Number
Two Wafer Padded	DE8	8417868
Two Wafer Padded	AC127	9334439

Wear Limit (long side)
- Adjustable Pressure Brush Holder . . . . . 40 mm (1-9/16″)
- Constant Pressure Brush Holder . . . . . 29 mm (1-1/8″)

Spring Tension
- Adjustable Pressure Brush Holder . . . . . 1.8 kg to 2 kg (4 to 4-1/2 lbs)
- Low Limit (worn brush) . . . . . 1.6 kg (3-1/2 lbs)
- Constant Pressure Brush Holder . . . . . 1 kg (2.43 lbs)

ALTERNATOR BRUSH HOLDERS

- Brush Holder (1 Mounting Bolt) 8449414
- Brush Holder (2 Mounting Bolts) 8271182
- Number Of Brush Holders 4

Clearance – Bottom Of Brush Holder To Collector Ring . . . . . 3 mm +1.6, -0.0 (1/8″ +1/16, -0)

ALTERNATOR BRUSHES

Number Of Brushes 4

Brush Type	Brush Grade	Part Number
Solid	AY	8413190
Solid	AY	8271183

8413190 Brush Size . . . . . 56 mm x 19 mm x 10 mm (2-3/16″ x 3/4″ x 3/8″)

8271183 Brush Size . . . . . 38 mm x 19 mm x 10 mm (1-1/2″ x 3/4″ x 3/8″)

Commutator
- Diameter – minimum . . . . . 870 mm (34-1/4″)
- Neck Width – minimum . . . . . 19 mm (3/4″)
- Mica Groove Depth . . . . . 1 mm to 2 mm (3/64″ to 5/64″)
- Mica Groove Width . . . . . 0.8 mm (0.030″)

TORQUE VALUES

- Coupling Disc (Lubricated Texaco Threadtex) . . . . . [illegible]
- Engine To Generator Coupling Disc Bolts . . . . . [illegible]
- Engine Base Bolts . . . . . 617 N·m (455 ft-lbs)
- Generator Base Bolts . . . . . 1627 N·m (1200 ft-lbs)

SERVICE DATA (CONT'D)

RESISTANCE MEASUREMENT LIMITS (IN OHMS AT 75° C)

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

$$\text{resistance at } 75^\circ \text{ C} = \frac{\text{measured resistance x } 309.5}{234.5 + \text{temperature of item being tested in } ^\circ\text{C}}$$

Model D32 Generator

	Min.	Max.
Armature	.00260	.00270
Armature (1-10)	.00174	.00191
Main Circuit A-D	.00445	.00463
Interpole A-B	.00221	.00230
A-E	.00221	.00231
Differential Field C-D	.00136	.00142
D-F	.00137	.00142
Compensating Field E-F	.00348	.00362
B-C	.00350	.00366
Starting Field	.00572	.00596
*Shunt Field (F+ and F-)	90.78	94.48
*Battery Field	1.15	1.21
**Separately Excited Fields:		
FP1-FN2 (with FN1 connected to FP2)	2.13	2.21
***Separately Excited Fields:		
FP1-FN2 (with FN1 connected FP2)	2.02	2.10

*Not on Model D32D and D32E
**Model D32D only
***Model D32E only

Model D22 Generator

	Min.	Max.
Armature	.00306	.00318
Armature (1-10)	.00204	.00212
Main Circuit A-D	.00480	.00498
Interpole A-B	.00220	.00228
A-E	.00222	.00231
Differential Field B-C	.00140	.00146
F-D	.00140	.00146
Compensating Field E-F	.00393	.00409
C-D	.00396	.00412
Starting Field	.00561	.00583
Shunt Field (F+ and F-)	90.78	94.48
Battery Field	1.15	1.21

Model D12 Generator

	Min.	Max.
Armature	.00306	.00318
Armature (1-10)	.00204	.00212
Main Circuit A-D	.00480	.00498
Interpole A-B	.00220	.00229
A-E	.00222	.00231
Differential Field B-C	.00136	.00141
F-D	.00136	.00141
Compensating Field F-E	.00393	.00409
C-D	.00396	.00412
Starting Field	.00560	.00583
Shunt Field	91.2	95.9
Battery Field (F+ and F-)	1.15	1.21

Alternator

	Min.	Max.
Rotor – Collector Ring To Collector Ring	2.13	2.29
Stator – Phase To Phase	.00965	.01045
Maximum Allowable Variation Between Any Two Phases		.0001

BEARING ASSEMBLY

Outer Diameter	279.999 mm + 0.00 mm - 0.036 mm (11.0236″ + 0.000″ - 0.0014″)
Bearing Bore	129.999 mm + 0.00 - 0.03 mm (5.1181″ + 0.000″ - 0.001″)
Bearing Width	92.99 mm + 0.00 - 0.13 mm (3.661″ + 0.000″ - 0.005″)
Internal Clearance (Before Assembly)	0.089 mm to 0.13 mm (0.0035″ to 0.005″)
Internal Clearance (After Assembly)	0.05 mm Minimum (0.002″)
Bearing Housing Bore	280.020 mm + 0.03 mm - 0.00 mm (11.0244″ + 0.001″ - 0.000″)
End Play Clearance (After Assembly In Generator Housing)	8 mm (5/16″)

Bearing Lubricant Capacity

Bearing Cap	454 g (16 ozs)
Bearing	397 g (14 ozs)
Bearing Cover	454 g (16 ozs)

EQUIPMENT AND MATERIAL LIST

EQUIPMENT

	Part No.
Megger, Insulation And Resistance Tester	8174880
Ammeter, Zero Center Reading (50 millivolt movement)	
Battery, 6 Volt Storage	
Switch, Toggle	
Commutator Grinder	8355891
Commutator Grinder Adapter	8195928

SERVICE DATA (CONT'D)

Grinder Alignment Bar	8210141
Vacuum Cleaner Blower	8210140
Dust Collector	8210142
Grinding Stones, Finish Grade – 2 Req'd.	8201791
Grinding Stones, Medium Grade – 2 Req'd.	8496921
Brush Seating Stone (Chalk Stone)	8204957
Sandpaper, 220 Grit – 216 mm x 46 m (8-1/2" x 50 yd.) roll, 3 m (10 ft) per generator	19AB12
Brush Tension Scale	8415805
Dial Indicator Support Rod	8122000
Dial Indicator Support Rod	8133046
Armature Bearing Alignment Stud	8159226
Armature Bearing Alignment Guide	8159227
Hydraulic Main Bearing Puller	8173948
Manual Main Bearing Puller	8168577
Manual Main Bearing Puller – Export Only	8213622
Commutator Slot File Assembly	8217141
Generator Lifting Shackle – Includes Pin (2 Req'd)	8249739
Shackle Base (2 Req'd)	8097939
Shackle Base Bolts (8 Req'd)	272580
Pyrometer	8364533
Grease Contour Mask, Bearing Cap And Cover	8276640
D14 Alternator Rotor Lifting Sling	*File No. 924

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

MATERIAL

	Part No.
Twine, Torpedo 1.6 mm (1/16" diameter)	
0.2 kg (1/2 lb) ball	8192837
23 kg (50 lb) spool	8122563
Tape, Vinyl, 0.25 mm x 25.4 mm (.010" x 1")	8192816
Tape, Fiberglass Adhesive, 0.18 mm x 25.4 mm (.007" x 1")	8395904
Tape, Fiberglass Adhesive, 0.18 mm x 19 mm (.007" x 3/4")	8394836
Tape, Friction, 33 m (36 yd) roll	8175276
Enamel, Gray Locomotive	8106297
Cloth, Empire, 46 m (50 yd) roll	8116923
Caulking Compound, 1 liter (1 qt)	8133954
Solder, Hi-Temp 2.76 mm (0.109") diam., approx. 32 kg (70 lb) spool	8160923
Solder, Tin Base (No. 8 wire, approx. 23 kg (50 lb) spool	8225761
Solder, Sil-Fos	8129496
Solder Piece (Separately Excited Field)	8158703
Solder Flux, 0.5 kg (1 lb)	8122570
Brazing Flux, Low-Temp, 0.5 kg (1 lb)	8116442
Varnish, Black Air Drying	
1 liter (1 qt.)	8061114
4 liters (1 gal)	8122347
208 liters (55 gal)	8116521
Enamel, Red Air Drying	
1 liter (1 qt)	8061130
19 liters (5 gal)	8048876
Bearing Lubricant, Esso Unirex N-2	
16 kg (35 lbs) Drum	9507146
54 kg (120 lbs) Drum	9507147

Thread Lubricant, Texaco Threadtex 19 litres (5 gal) 8307731
Molykote Lubricant
Aerosol, 0.473 liters (1 pt) 9316707
Paste, 0.473 liters (1 pt) 9517921
Varnish, Electrical Insulating – Modified Polyester Y-432 (Sterling Varnish Co.)
Thinner Solvent For Above Varnish
*Chevron No. 1300 Solvent
*Thomspon – Hayward Chemical Company No. 2026 Solvent
**Xylol Thinner
An alternate thinner solvent may be blended using the following materials:
*Mineral Spirits (Rule 66 Type Thinner) 80%
*Butyl Acetate – Technical Grade 20%

NOTE

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

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

• • • • A Service Department Publication • • • •

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

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