

MAIN GENERATOR—TYPES D32, D22 AND D12

DESCRIPTION

The Model D32, D22 and D12 generators are very similar in appearance and construction. The main difference in appearance is the removal of the external bus bars on the D32, Fig. 1. Due to the similarity of the generators, the instructions contained in this bulletin will apply to all three models unless otherwise noted.

The generator produces nominal 600 volt direct current to supply power to the traction motors. It is connected directly to the engine crankshaft through the alternator rotor spider and a flexible coupling.

A self-aligning, double row, spherical roller bearing carries the weight of the commutator end of the armature. The other end is supported by the engine rear main bearing.

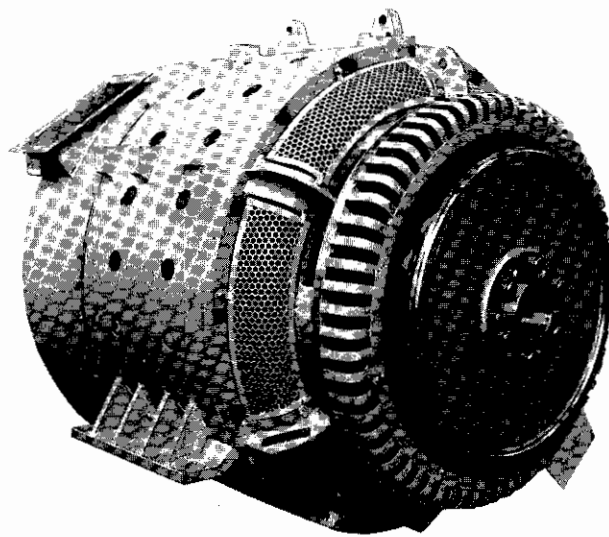
An impeller, mounted on the end of the auxiliary generator shaft, provides forced ventilation for the main generator.

GENERATOR FIELDS

The generator contains six types of fields as follows:

Starting — The starting field is used only while the engine is being started. The current for the starting field is supplied from the storage batteries.

Differential — The differential field is wound so that it is differential to the shunt and battery fields. The differential field is connected in series with the armature,



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Fig. 1 — D32 Generator-Alternator Assembly

and its purpose is to maintain a constant kilowatt output.

Shunt — The shunt field is connected in parallel with the armature and is excited by the armature of the main generator. The current for excitation of the shunt field is only a small portion of the total available load current.

Battery — The battery field is a separately excited field and is connected to the battery and auxiliary generator circuit. The battery field is under the control of the load regulator which serves to maintain a constant horsepower demand on the engine for any ampere demand within the capacity of the generator and load regulator.

Interpoles — The interpoles or commutating poles are connected in series with the armature, and are excited by the load

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

current, which in turn produces a magnetic field in such a direction as to assist the reversal of the current in the armature coil undergoing commutation. The function of these fields is to bring about better commutation.

Compensating — Copper conductors are placed in slots of main pole faces approximately parallel to the armature conductors and connected in series with the armature circuit. The purpose of this field is to reduce armature reaction upon the main field so as to bring about better operating conditions.

Armature windings are of skewed core design to improve voltage wave form and increase generator efficiency.

MAINTENANCE

Electrical insulation gradually deteriorates or weakens under normal service from heat, dirt, moisture and age. The rate at which insulation deteriorates depends on the service and care to which it is subjected. The total useful life can be increased by keeping the insulation clean and protecting it from moisture. Insulation can also be rejuvenated, or some of its original life restored, through periodic overhaul and by thorough cleaning and vacuum impregnation. This process also protects the insulation from the deteriorating effects of dirt and moisture.

Since the life of the insulation depends upon the above factors, the length of time between overhauls will depend on factors not controlled by the manufacturer. However, it is recommended that generators be overhauled with approved materials and by proper processing as often as outlined in the applicable Scheduled Maintenance Program. If proper equipment for maintenance and overhaul is not available, the generator should be returned to Electro-Motive whenever either becomes necessary.

Cleaning

It is essential that the generator be kept clean at all times. The generator should be blown out with clean dry compressed air whenever conditions warrant, and at periods as outlined in the applicable Scheduled Maintenance Program.

The generator should not be cleaned with liquid of any kind. Cleaning the coils and windings with a liquid cleaner may cause low megger readings. All that is necessary is to blow out the dust and dirt with clean dry compressed air, often enough to prevent any accumulations. A large volume of air at reasonably low pressure should be used. If a high pressure from a nozzle is used, there is danger of loosening the binding tape and cutting the protective coating on the various parts.

In cases where there are heavy deposits of grease or dirt which cannot be removed with air and dry cloths, a stiff brush, soft wooden or fibre scrapers may be required. If commutator becomes oil sprayed, dampen a cloth in a solvent type cleaner to remove oil. However, every precaution should be taken to keep the cleaner off the commutator and copper parts. This type of cleaner should be used only when other methods will not remove the foreign material.

After cleaning, and if necessary, the inside of generator end housing may be painted with one coat of red air-drying enamel.

Inspection

The generator should be inspected at intervals as specified in the applicable Scheduled Maintenance Program. These inspections will insure operational efficiency and determine what maintenance is required to prevent failure in service. Specific inspection procedures for generator components are included in this bulletin.

Lubrication

The main generator bearing is a self-aligning, double row, spherical, grease-lubricated bearing.

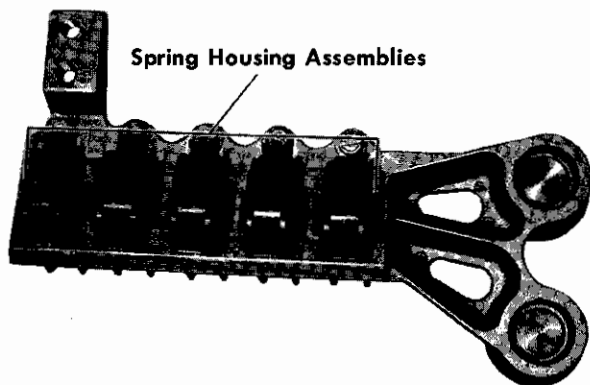
On generators having an additive type bearing, grease is applied through a fitting located on the front of the bearing cover. One ounce of Lubrico M6 is added periodically, as specified in the applicable Scheduled Maintenance Program. Inspect grease fitting regularly for damage which would permit dirt to enter the bearing. Prior to lubrication, fitting should be wiped clean to prevent dirt being forced into bearing.

For generators having sealed grease-lubricated bearings, Shell Cyprina RA-3 or Texaco Regal Starfax #2 are the approved lubricants. Bearing lubrication intervals are as specified in the applicable Scheduled Maintenance Program.

N. L. G. I. #3 grease is approved for sealing the labyrinth grooves in the bearing cover and cap at overhaul or whenever cover or cap is removed and replaced.

BRUSH HOLDERS AND BRUSHES

The D32 generator uses a redesigned brush holder which incorporates five constant pressure spring housing assemblies as shown in Fig. 2. The housing assembly is constructed of a polyester glass holder

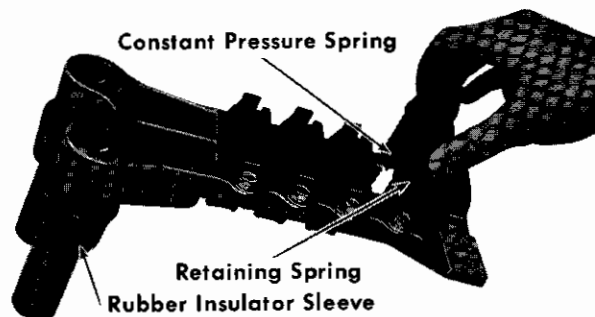


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Fig. 2 — D32 Constant Pressure Brush Holder Assembly

with two constant pressure stainless steel springs which exert a pressure of 3.28 lbs. on each brush wafer.

To remove the brushes the spring housing assembly must first be removed by depressing the springs on each side as shown in Fig. 3. This releases the housing assembly from the brush holder and allows the brushes to be lifted from the brush holder carbonways.



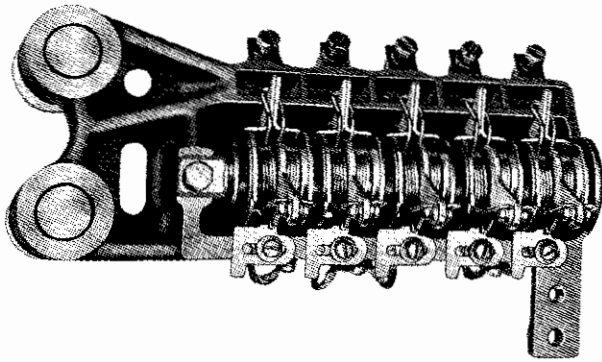
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Fig. 3 — Removal Of Brush Pressure Spring Housing From Constant Pressure Brush Holder

A new, thicker brush is used to improve frictional characteristics and commutation. The brush is mounted in the holder so the heel or short side makes contact with the commutator surface first, resulting in reduced friction and copper drag.

The D12 and D22 generators use the spring type brush holder shown in Fig. 4. Regardless of the type of brush holder used, a periodic inspection of brushes and brush holders should be made and the following points observed:

Brushes should move freely in the brush holder. If the adjustable spring type holder is used, release the springs from the anchor pin, and raise and lower the brushes in the carbonways to remove any dirt that may have accumulated. Care should be taken not to snap the spring, as this may damage the spring and chip the brush. With the D32 generator constant pressure



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Fig. 4 — D12, D22 Brush
Holder Assembly

brush holder, the spring housing assemblies must be removed, as previously explained, before the brushes can be raised and lowered.

Excessively worn or chipped brushes should be replaced with the type recommended by the locomotive manufacturer. If a full set of brushes is not required, the replacement brushes should be the same type as those remaining in the generator. A mixed set may result in unsatisfactory operation. Refer to Maintenance Data for brush type and wear limit.

When a full set of brushes is replaced, it is important that the brushes are properly seated. The friction created by improperly seated or unseated brushes may result in the commutator heating to a point of melting and throwing solder. Brushes should be seated by idling the engine and using seating stone 8204957, Fig. 5. A 90% seat is satisfactory.

The constant pressure type brush holder springs need no adjustment as the pressure will remain the same throughout the brush life, regardless of the brush length. The adjustable type spring tension should, however, be maintained as specified under Maintenance Data. It is important that all brushes be adjusted to the same pressure, as unequal brush pressure will cause



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Fig. 5 — Seating Brushes

unequal current distribution in the brushes. Measure the spring tension with the lever arm 1/8" above the top of the brush holder box. Refer to Fig. 6 for method of measuring brush spring tension.



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Fig. 6 — Measuring Brush Spring Tension

An adjustable type brush holder spring may lose some tension during the first few weeks of operation, due to aging of the spring. Springs should be checked occasionally during this period and tension reset if necessary. After one adjustment, they should retain their tension.

The spring tension on the brush holder is regulated as follows:

1. Release the springs from the anchor pin and remove brushes from brush holder to be adjusted.
2. Remove capscrew holding clip and remove clip.
3. Move anchor assembly to the desired slot (usually second or third slot). Install clip and secure with capscrew.
4. Insert springs to anchor pin.
5. Care must be used in measuring spring tension because of spring and finger friction. To eliminate friction, wiggle finger and spring while holding tension or take an average reading while raising and lowering fingers with tension scale.

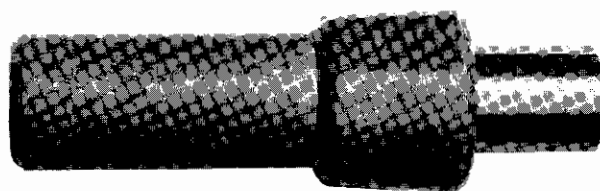
BRUSH HOLDER STUDS

Keep brush holder stud insulation clean. Do not let oil or dirt accumulate on brush holders. Wipe brush holders with a clean dry cloth. Replace brush holders when stud insulation is broken, cracked, carbon tracked or burned to the extent that it cannot be cleaned. Replacing brush holders as an assembly, Fig. 2, saves time required to replace or repair stud insulation.

Later model brush holder assemblies have rubber insulated sleeve 8303195 over the base of the brush holder studs, Fig. 3. When replacing or reconditioning older brush holder assemblies be sure to install insulating sleeves.

All porcelain type brush holder studs should be replaced with polyester studs, Fig. 7. The polyester glass insulation is more durable than other types in that it is less susceptible to breakage, and does not become permanently carbon tracked. In the event a flashover occurs, this type of insulation can be put back in serviceable condition by polishing the surfaces with fine sand paper.

CAUTION: Polyester glass should not be subjected to alkaline cleaning solutions.

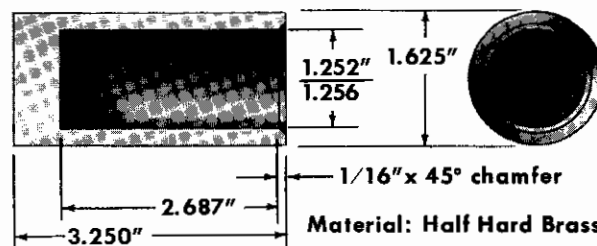


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Fig. 7 — Polyester Brush Holder Stud

The polyester studs are available in three sizes: standard, .002" oversize, and .031" oversize. The standard size 8159003 is for use in new brush holders or in stud holes within the $.9935'' \pm .0005''$ limits. The .002" oversize stud 8209068 (identified by a figure "2" stamped on the end) is intended for use in brush holders which have had the standard size stud pressed out. The .031" oversize stud 8209069 (identified by a figure "31" stamped on end) is intended for use on brush holders which have extensive score marks, making it necessary to ream the holes.

A sleeve type tool, Fig. 8, should be used for pressing the polyester glass insulated studs into the brush holders.



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Fig. 8 — Sleeve Type Tool

To replace the porcelain type brush holder studs with a polyester type, proceed as follows:

1. Press out porcelain type brush holder studs, shearing retaining pins.
2. Clean up internal press fit surface of brush holder, if necessary.
3. Press in proper oversize polyester insulated stud making sure that .002" + .001" press fit is obtained.

NOTE: Clearance between the polyester stud shoulder and brush holder must be maintained to insure against bottoming the insulation against the brush holder and damaging the insulation. The clearance should be as close to the minimum figure as possible, see Fig. 9.

4. Drill and pin brush holder and stud. Use #23 drill and pin 8042533. Peen over hole after installing pin.

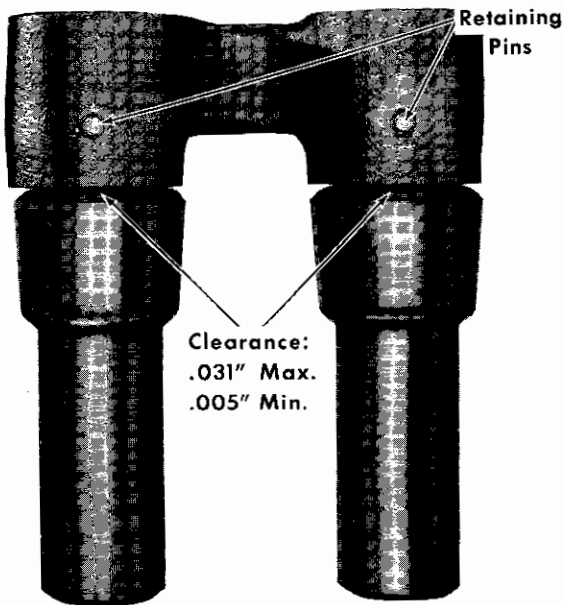


Fig. 9 - Polyester Studs Installed

D12 AND D22 BRUSH HOLDER

Lever And Shaft Assembly Removal

1. Free springs from anchor pins.

2. Remove bolt from shaft assembly and remove shaft and lever assembly from brush holder.
3. Use snap ring pliers and remove snap ring and washer. The individual assemblies may then be slipped off the shaft.

Lever And Shaft Assembly Installation

1. Assemble anchor and pin assembly, lever and shunt assembly, and spring to bushing. Assemble bushing to shaft. Five such assemblies constitute one brush holder lever and shaft assembly. When the last assembly is placed on shaft, assemble washer to shaft and apply snap ring to shaft using ring installing tool.

NOTE: Use a new snap ring and discard the old ring.

2. When installing complete lever and shaft assembly, use a U-shaped tool, as shown in Fig. 10, to aid in the installation of the assembly to the brush holder. The U-shaped tool can be made as shown in Fig. 11.
3. Apply clips to hold anchor assembly on brush holder and set spring tension as previously outlined.

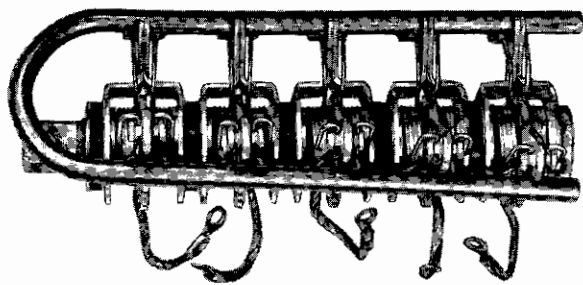


Fig. 10 - Lever And Shaft Assembly U-Shaped Tool

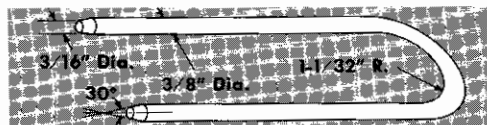


Fig. 11 - U-Shaped Tool Assembly

4. Maintain $1/8'' + 1/16'' - 0''$ clearance between bottom of brush holder and commutator, Fig. 12. The brush rigging is arranged so that brush holder may be moved in toward commutator surface as the commutator wears or is turned. This will maintain the $1/8'' + 1/16'' - 0''$ clearance between the face of brush holders and the commutator. Brush holders should be kept rigidly bolted in place.
5. Care must be taken, when brush holders are removed or replaced, that the cutting from the lock washer does not become lodged among the other brush holders or brushes.

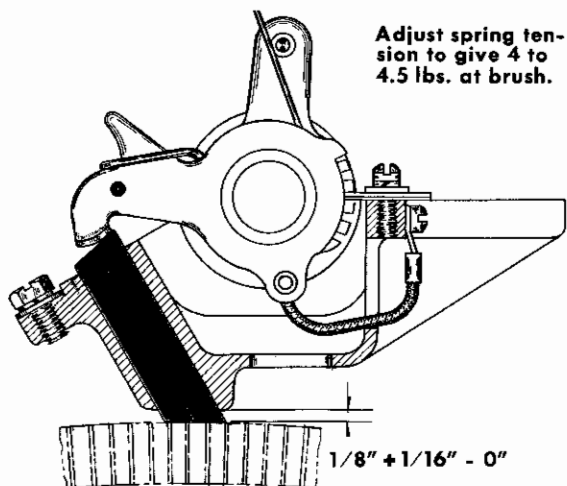


Fig. 12 — Brush Holder Clearance

GENERATOR-ALTERNATOR DISASSEMBLY

Before the generator is removed from the locomotive unit, place strips of fish paper $1/16'' \times 3'' \times 36''$ in the bottom air gap between the armature and the field pole cores.

NOTE: Fish paper does not have to be placed between the alternator rotor and its stator.

Brushes should be removed from commutator and collector rings, and a ring of fish paper placed around the commutator for protection.

After removal from the locomotive unit disassemble as follows:

1. Mount the generator-alternator assembly on a sturdy stand such as steel I-beams, at a suitable height from the floor. Use anchor shackle and base fixture for lifting complete generator assembly.
2. Remove friction and Empire tape from bolted connections and remove bolts from bus bars. Remove cleats and straps and remove bus bars. Remove conduit pipe and clamps bolted to commutator cover. On generators without compressor coupling remove collector ring cover.
3. Remove cables from collector ring brush holders to terminal board. On models where compressor coupling and guard are applied, remove the compressor guard. Remove commutator covers and air box assembly.
4. Apply arbor fixture to spider bore of alternator rotor.
5. Remove bolts holding end housing to generator frame.
6. Using two wire cable loops, attach one loop to the arbor fixture and attach the other loop to the end housing web, as shown in Fig. 13. With aid of crane, raise back end and space the rotor air gap in the stator frame. With the aid of a second crane, raise the front end until the cable is taut.
7. Insert 3 jack bolts in the $3/4''$ 10 N.C. class 3 thread tapped holes provided in end housing, and free housing from generator frame.
8. Ease the armature and the alternator rotor out of frame toward commutator end. Care must be exercised not to injure the laminations or windings. Do not allow the armature to rub on the poles while it is being removed.

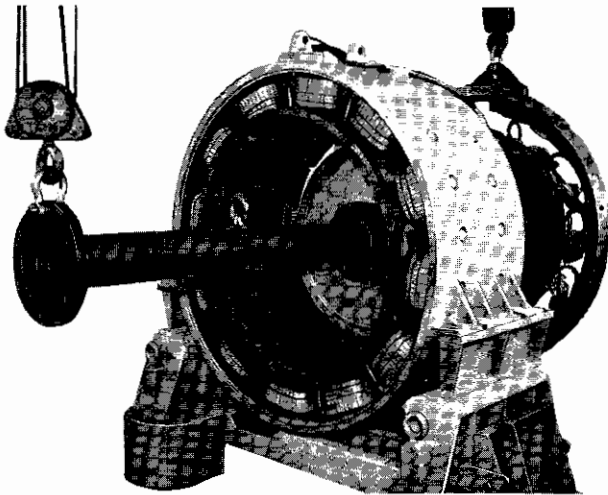


Fig. 13 — Removing Armature Assembly
From Stator

9. Rest the armature in an armature cradle. The cradle should be high enough from the floor to clear the bus connection on the end housing.
10. Remove collector ring cable from terminal posts. Remove bolts holding flange to generator shaft and remove flange.
11. Disassemble and remove compressor coupling and collector ring assembly by applying studs to the 1/2" - 13 N.C. class 2 tapped holes. Studs should be long enough to permit use of pulling plate or hydraulic puller. On generators which do not have the compressor coupling, the studs are applied directly to the collector ring assembly.
12. Remove collector ring brush holders from studs pressed in bearing cover.
13. Apply studs to the 7/16" - 20 N.F. class 3 tapped holes, and remove sleeve from shaft.
14. Remove bolts from the bearing cover and remove cover. Cover may be removed by tapping with a rawhide mallet or soft metal hammer and prying with a pry bar.

15. The generator end housing is now free and can be slid off the bearing.
16. To remove the remainder of bearing assembly, insert 8 studs in the 1/2" - 20 N.F. class 3 spline nuts pressed into the bearing cover. With the aid of a pulling plate, Fig. 14, or hydraulic puller, remove the inner and outer oil ring, roller bearing and bearing cap. All 8 studs are to be used when studs are applied to the bearing cap, as there is the possibility of breaking the cap when fewer studs are used.

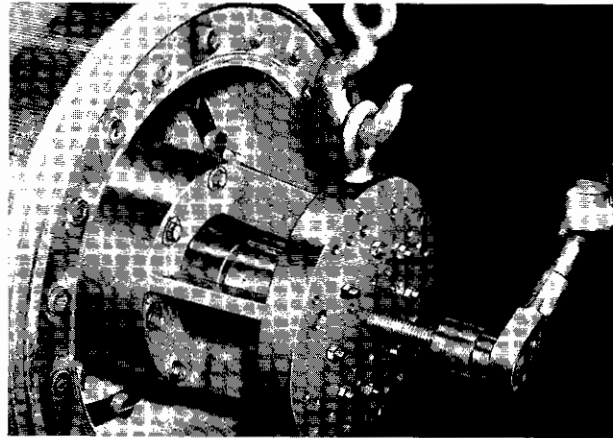


Fig. 14 — Main Bearing Pulling Plate

For removal of alternator stator from main generator stator, or for removal of alternator rotor from generator spider refer to applicable Maintenance Instruction covering alternating current generators.

STATOR ASSEMBLY

Cleaning

Clean stator assembly to remove all carbon dust, grease and dirt. The granulated corn cob material applied with a controlled air blast method for cleaning and degreasing of electrical equipment

and insulation has been found to be satisfactory. This method produces a clean, dry, bright, oil free surface suitable for immediate varnish treatment.

When cleaning electrical equipment with the granulated corn cob 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 are from 45 to 60 pounds per square inch.

After the cleaning operation is completed, the cleaning material (granules) trapped in pockets or crevices should be blown free by a straight air blast at reduced air pressure.

When the above described process or equipment is not available, petroleum solvent Apco #42 (Stoddard Solvent - flash point 115° F.) may be used. The solvent is generally used by wiping the frame and insulation with a cloth dampened with the cleaning fluid. All insulation must be protected against moisture and the use of strong solvents.

CAUTION: Use the usual safety precaution that applies to inflammable fluids. Provide adequate ventilation when any type of solvent is being used.

After cleaning with petroleum solvent the stator assembly should be thoroughly dried out by placing it in a 115°-125° C. convection type oven from 3 to 6 hours.

NOTE: Drying will not be necessary after cleaning, if a dry cleaning process has been used, unless megohm-meter check so warrants. See circuit test before making high potential test.

Inspect the condition of the insulation on the main pole and interpoles for charred or damaged insulation, or any other condition.

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

It is not recommended to remove pole cores from field assemblies. Loose poles should be retightened and loose ties must be replaced.

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

To remove a field pole or an interpole, the generator must be removed from the unit and disassembled as previously explained.

Before removing any field poles from stator assembly, obtain a measurement, with inside micrometer, from pole face of pole to be removed, to the diametrically opposite pole face and record this measurement. Obtain a pole spacing measurement between the side of main pole core and the side of the adjacent interpole cores, and record this measurement. These measurements will aid in alignment when installing new poles. Remove excess varnish from points of measurement.

Field poles or interpoles should be removed as a complete assembly, and the defective assemblies should be returned to Electro-Motive. Main pole and interpole assemblies are only serviced as complete units.

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 generator 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 1-27/64". The total variation between these spacings shall not exceed .050".

2. Every interpole air gap on any one machine shall be within plus or minus .010" of the average interpole air gap of that machine.
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 1/32".

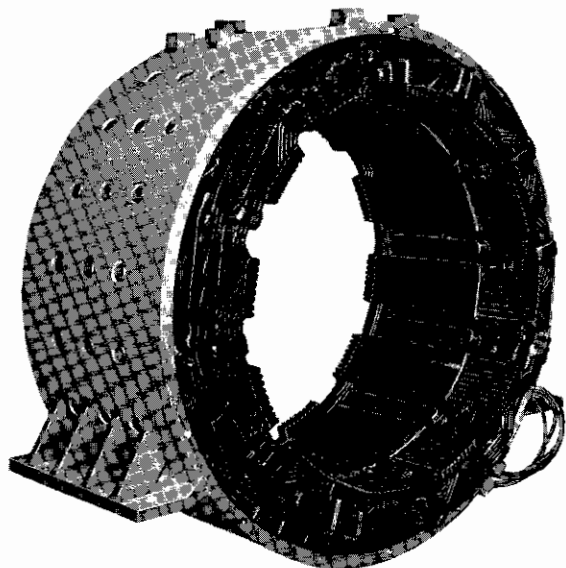
Models D12 and D22 have all cable and connection joints other than interpoles, shunt field, battery field and compensating field connectors soldered with Hi-Temp solder 8004399. Battery field and compensating field connectors are soldered with tin base solder 8004402. (Flux with Noko-rod soldering paste before soldering). Shunt field coil lead connections have pressure applied crimp type connectors. Braze all interpole connector joints using brazing tongs and Sil-Fos solder 8004440. Care should be taken to prevent solder from running down the field conductors when performing any of the soldering operations.

Model D32 generator has all cable and connection joints other than the shunt field and battery field connectors brazed. Battery field connectors are soldered with tin base solder 8004402. (Flux with Noko-rod soldering paste before soldering). Shunt field coil lead connections have pressure applied crimp type connections. Care should be taken to prevent solder from running down the field connectors when performing any soldering operations. Fig. 15 shows a D12 and D22 generator field assembly and Fig. 16 shows a D32 generator field assembly.

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.

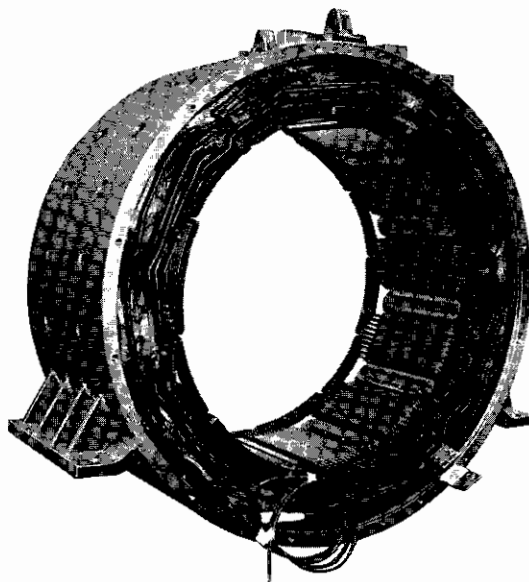
Insulation of D12, D22 and D32 Connections

Connections, straps and cable leads to coils should be inspected to determine if they are electrically and mechanically secured.



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Fig. 15 — D12 And D22 Generator
Field Assembly



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Fig. 16 — D32 Generator
Field Assembly

All shunt field soldered connections are insulated with 2 layers of vinyl tape half overlapped and 2 layers of friction tape half overlapped.

Insulate all battery field connections with 2 layers of vinyl tape half overlapped and 2 layers of adhesive tape (8168002) half overlapped.

Starting and differential field connectors are not insulated, but are painted with red air-drying enamel after soldering or brazing.

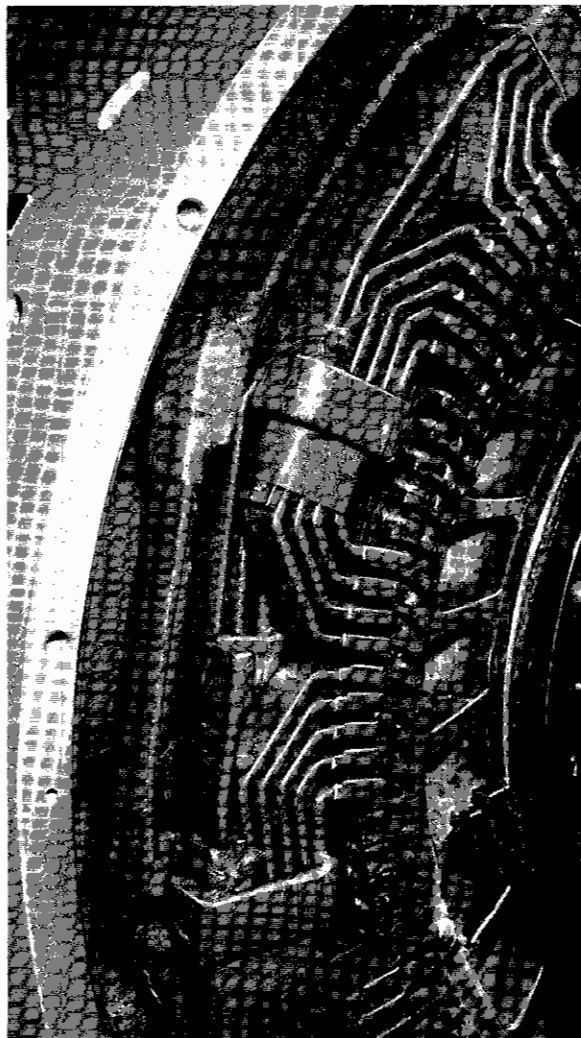
Insulate all brazed interpole connections, except those next to the frame, with 2 layers of vinyl tape half overlapped and 2 layers of friction tape half overlapped.

Insulate all interpole connector assemblies next to the frame with 2 layers of vinyl tape half overlapped and 2 layers of glass adhesive tape half overlapped.

All loose lead connectors should be tied with 1/16" torpedo twine and fish paper insulators tied-in where necessary; paint with red air drying enamel.

D32 compensating field connectors have been changed from a radial plane as on D12 and D22 generators, Fig. 17, to a cylindrical plane as shown in Fig. 19. The D32 compensating field connections are brazed instead of soldered as they were on the D12 and D22 generators. These connections, whether brazed or soldered, are not insulated with vinyl or friction tape, but are sprayed or painted with red air drying enamel.

The D22 generators use rubber damping strips between compensating field connectors on both ends of the stator. The damping strips are tied in place with two turns of treated glass tape as shown in Fig. 17. The D12 generator uses rubber spacers between the compensating field connectors which must be tied in place with 1/16" torpedo twine.

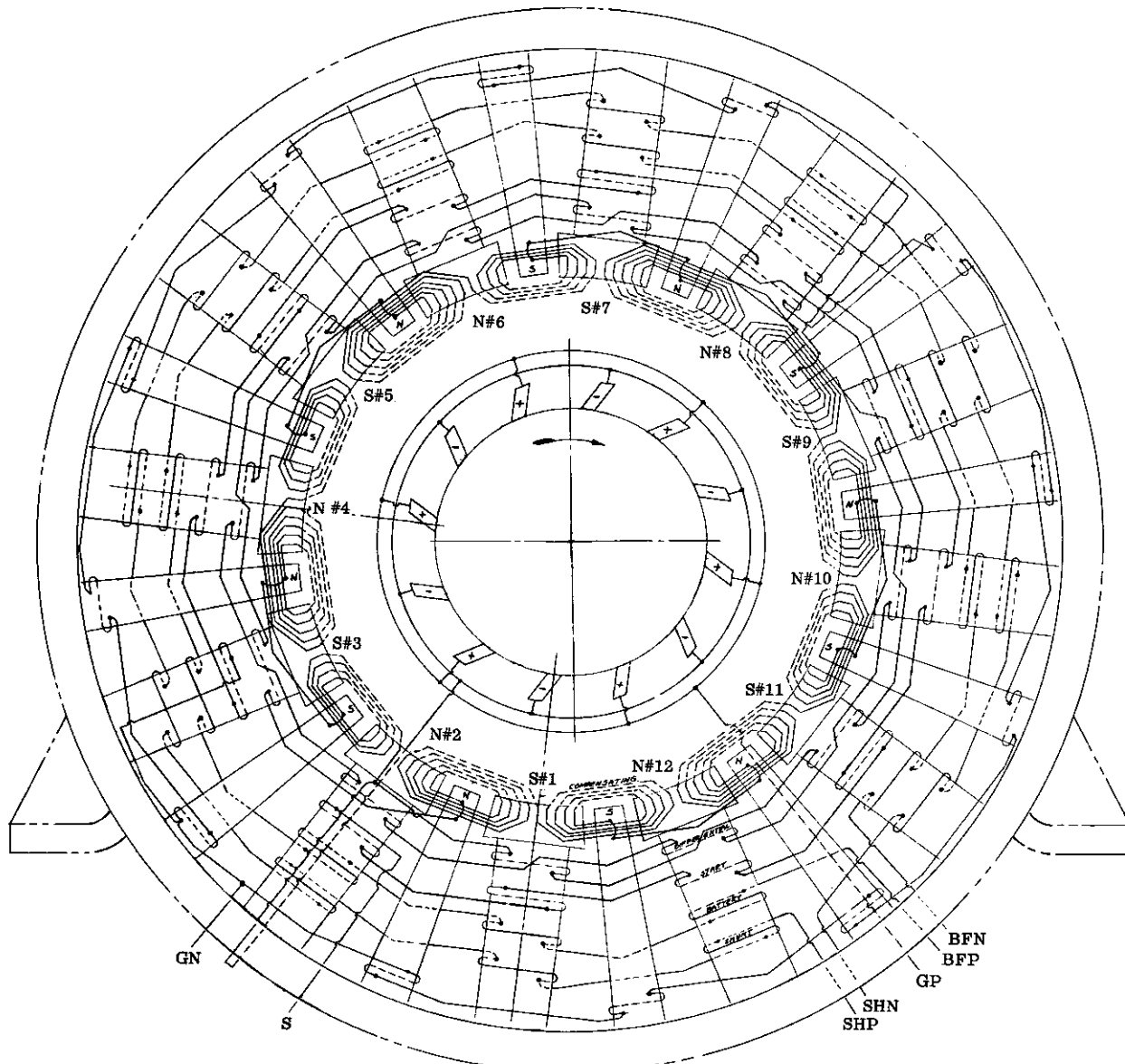


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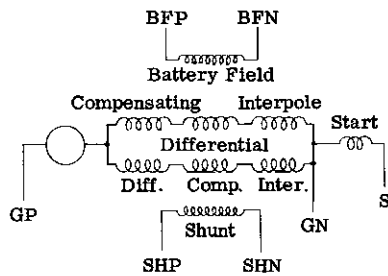
Fig. 17 — D22 Compensating Field Connection

After assembly, the stator should be varnish treated using varnish 8160879 thinned with Xylol 8089758 to maintain viscosity at 100-130 seconds Ford Cup #4 at 21.2° C.

1. Preheat the stator assembly in a convection oven so that the average steel frame and coil copper component temperature is maintained at 130° C. for one hour.
2. After removing the hot stator assembly from the convection oven immerse it completely in the varnish for five minutes.
3. Drain the varnish and allow the excess to drain from the assembly for five minutes.



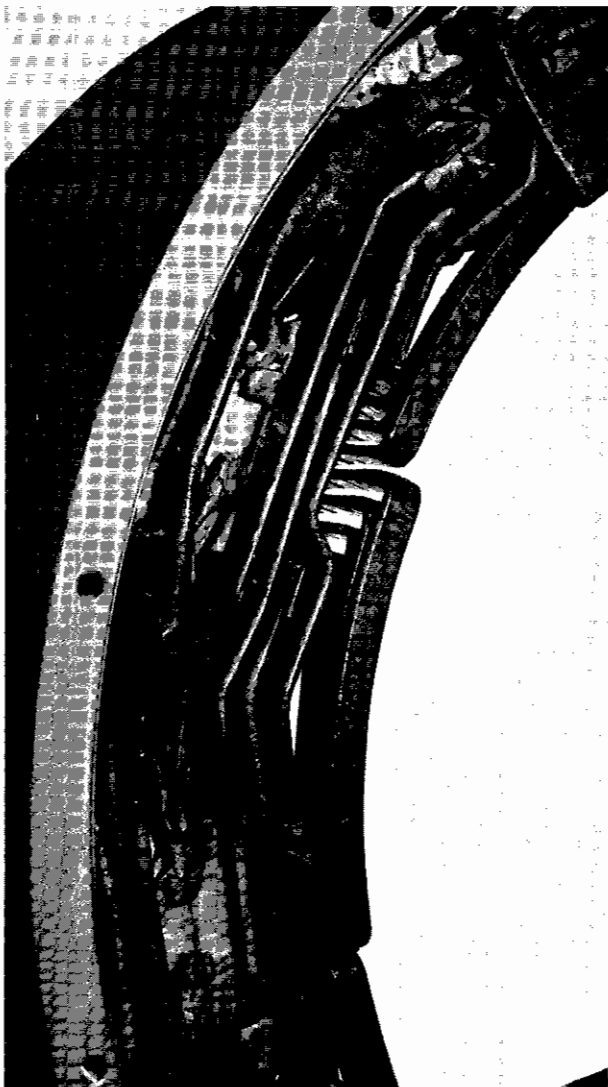
View Facing Rear End Of Generator
(Dotted Connections Are On Commutator End)



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Fig. 18 — D12 And D22 Generator Wiring Diagram

4. Clean the varnish from the stator frame bore faces.
5. Place the stator assembly back into the oven and bake it for 30 minutes at an average copper and steel temperature of 130° C.
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. Bake for six hours at 150° C. \pm 5°.



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Fig. 19 — D32 Compensating Field Connection

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

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 bolts should be painted with gray locomotive enamel.

Apply a high potential test of 4200 volts for 10 seconds on the main field and shunt field circuits. Apply a high potential test of 1200 volts on the battery field circuit for 10 seconds.

NOTE: Ground both sides of battery field circuit when hy-potting the shunt

field circuit; ground both sides of shunt field circuit when hy-potting the battery field circuit.

Make a resistance test of the fields and interpoles with Kelvin Bridge, see wiring diagram, Fig. 18 and 20. Refer to Maintenance Data for values.

ARMATURE

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. On older models which use wire bands, the soldering 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.

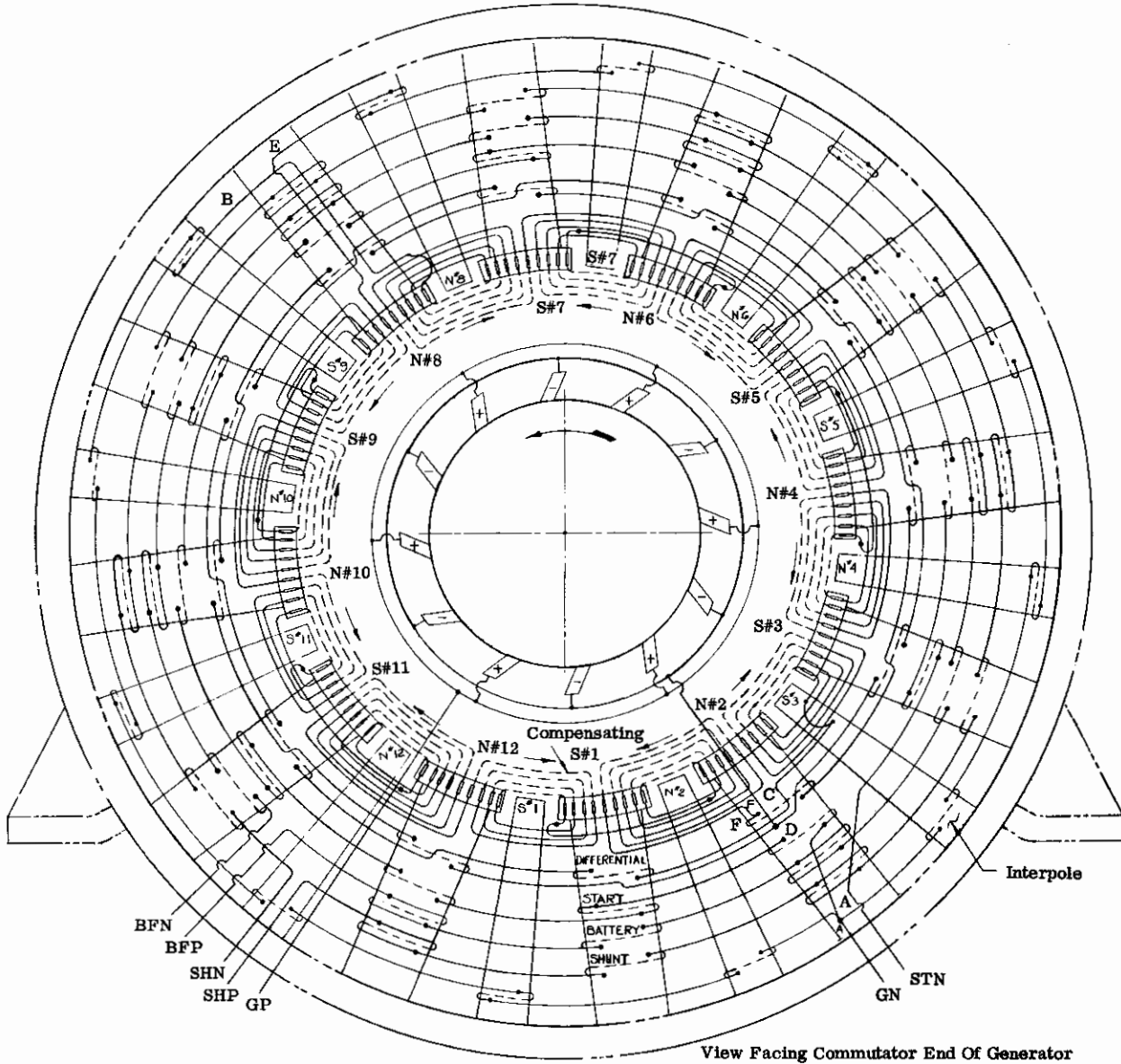
The coil insulation should be clean and free from blisters, flakes, or cracks on the insulating varnish surface. When the condition of the insulating varnish on the armature requires treatment, and the proper facilities for vacuum impregnating are not available, return the generator to Electro-Motive.

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

Commutator Polishing

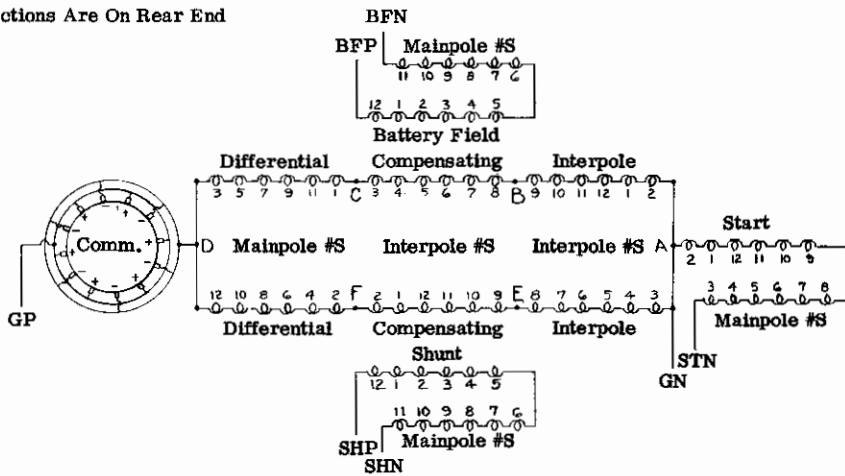
The surface of the commutator should present an even, smooth appearance, free from pitting. Under normal conditions where split type brushes are used, cleaning of the commutator with a cleaning stone should not be necessary.

Commutators, that have accumulated a grayish black film, which may result in the burning of the commutator bars, can be cleaned with an improved commutator cleaning stone 8149435. This stone will



Dotted Connections Are On Rear End

View Facing Commutator End Of Generator



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Fig. 20 — D32 Generator Wiring Diagram

remove film, dirt and grease like an eraser and does not affect the face of the brush or the commutator. After grinding, the stone can also be used to remove slight imperfections.

Commutator Grinding

In the event that the commutator is etched, burned or pitted to the extent that re-surfacing is required, grinding will be necessary. The following procedure is suggested to grind a commutator, using grinder 8052924.

If a new set of brushes is to be installed after grinding, remove all brushes except two adjacent sets, which will be used for starting the engine. These two sets can be left in, while grinding, provided new brushes are installed after grinding. The next step is to remove a brush holder (it is suggested that the first holder above the horizontal plane of the generator on the right side, looking into the commutator end, be removed).

The grinding fixture is made up of two parts, the supporting adapter and grinder. Mount the grinder on the supporting adapter and install as a unit in place of the brush holder, and securely clamp in the brush holder blocks, as shown in Fig. 21. Square the grinder with the commutator so that the grinder cross-feed will run parallel with the commutator bars. Check this, using grinder alignment bar 8210141.

Before grinding use a short stiff stencil brush and remove any grease or dirt from the commutator slots. The use of vacuum cleaner 8210140 is recommended to effectively collect copper and stone dust during grinding and final clean up, Fig. 21.

Mount stones so they are seated squarely on the commutator. With radial feed, pull stones away from commutator and start engine (run at idle speed for grinding). Feed stones onto commutator slowly until light contact is made, then run stones across commutator. To finish, run stones

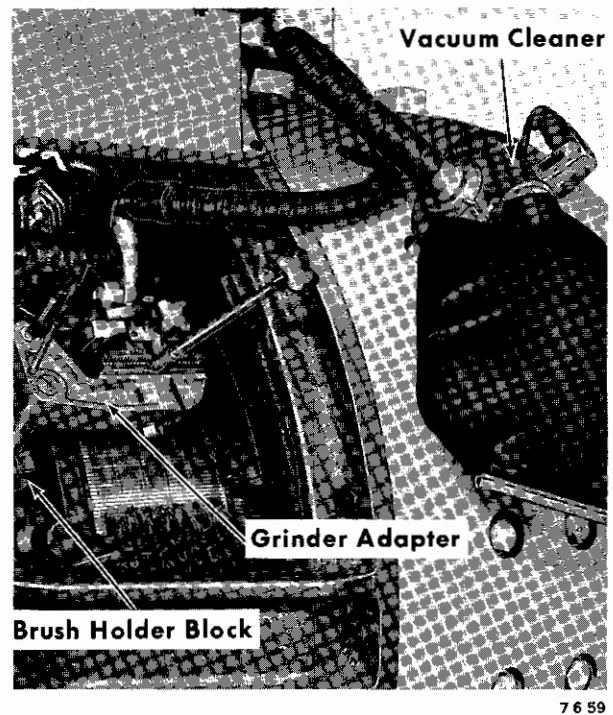


Fig. 21 — Commutator Grinding Fixture

across commutator several times without feeding radially. Remove stones and grinding fixture.

Clean commutator slots with slot file 8217141 and commutator cleaning stones 8149435.

After grinding the commutator, the generator should be cleaned thoroughly. First remove all of the loose copper from the inside of the generator. Using dry compressed air, blow the generator out thoroughly. To complete the removal of copper from commutator slots, run the engine and direct the air hose at the face of the commutator. Any copper remaining in slots, either in the form of dust or slivers, will result in flash-overs.

The slots between the commutator bars should be cleaned whenever examination shows that bright mica is not visible. To clean, use a hacksaw blade that has the tooth set ground off, and is of the proper thickness.

If the commutator is badly worn or burned, the generator should be removed and returned to Electro-Motive for service.

NOTE: Emery cloth or emery paper should NEVER be used on the commutator. It is unnecessary to use any lubricant on the commutator as there is a sufficient amount of graphite in the brushes to supply all the lubrication required.

Commutator Turning

If the commutator is damaged to such extent that grinding the commutator is not effective, the armature should be placed in a lathe and the commutator turned just enough to give a uniform surface. Before turning the commutator, a suitable covering should be placed over the end winding to prevent chips working into the armature. For a light machine cut, the speed of the armature should be 181 RPM or 1654 feet per minute. Use a carboloy-tipped lathe cutting tool when making a light cut, and finish with fine grinding stones.

Round off the ends of the commutator segments to at least 1/16" radius with a fine mill file.

Commutator Wear Limits

Overall Diameter — The generator commutator is designed for 3/8" radial wear, which gives a minimum diameter of 34-1/4".

Neck Width — When reworking the commutator, the face of the commutator is cleaned up by a light machine turned cut. When this operation has to be repeated a number of times, the minimum neck width allowable is 3/4".

Neck Diameter — The minimum diameter for cleaning up the outside diameter of the commutator neck is limited by the location of the top edge of the armature coil. The commutator neck diameter should not be machined below that point.

Commutator Undercutting

After the commutator has been turned, and then ground with fine stones, or after

checking the commutator surface and the surface is found to be in good condition, the mica should be undercut to a depth of 3/64" to 5/64" and a width of .030". When undercutting the width of the mica, a .030" undercutting saw 8085255 should be used.

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

Commutator Overhaul

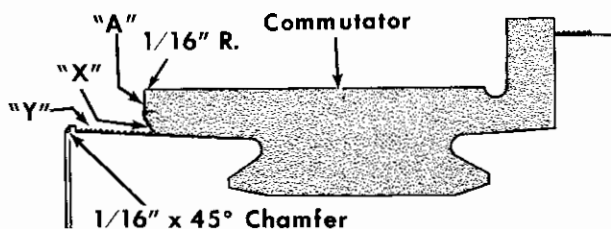
The duty performed by a commutator on a heavily loaded generator in railroad service is very exacting and calls for a commutator of a definite design, as well as highly accurate workmanship in assembling, which is done in a special air conditioned room. After a commutator has been assembled, there is a definite period of seasoning that requires many hours to prepare it for service.

All of this work requires special machinery that a customer would not be warranted in buying for the few commutators he might have to rebuild. Therefore, it is our recommendation that armatures be sent to our plant if the commutators have been damaged to the extent that they must be rebuilt.

In addition to the work and equipment required to rebuild a commutator, it is also necessary that the core be properly balanced after the commutator has been rebuilt. Such repairs should be handled on a repair and return basis.

Creepage Surfaces

1. Sandpaper the surfaces marked "A", "X" and "Y" with 00 grade sandpaper. Sand smooth applying a light pressure when sanding over the commutator string band. See Fig. 22.



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Fig. 22 — Creepage Surfaces

2. Clean surfaces thoroughly with alcohol.

CAUTION: Do not paint over carbonized insulation with insulating paint or varnishes. When the insulation has been carbonized from flash-overs, overloads, surface creepage through uncleaned insulation, moisture, or improper use of hy-pot machine, the generator should be removed if proper repairs can not be made in the locomotive. Do not run the generator while paint is wet. The paint should air dry in approximately one hour.

3. Apply the paint of the proper consistency with as thin a coat as possible, leaving no dabs or overlapping marks.
4. Extra care must be taken to see that no paint gets into the commutator slots or the relief at the bottom of commutator neck, or surface marked "A." This problem will be experienced if care is not taken in applying the paint or if the machine is run while paint is wet.

Flintflex Red (153-0895) is recommended for painting commutators because of its fast drying property. Thinner is not required for Flintflex, if container is kept tightly covered and brushes are clean and free of old paint.

Armature Cleaning (Armature Removed From Stator Assembly)

Generator armatures may be cleaned to remove all carbon dust, grease and dirt by the granulated corn cob process as outlined for cleaning stator assembly.

When the granulated corn cob process is not available, Apco #42 (Stoddard) solvent may be used. This solvent is generally used by wiping the insulation with a cloth dampened with the cleaning fluid.

CAUTION: Use the usual safety precautions that apply to inflammable fluids. Provide adequate ventilation when any type of solvent is being used.

After cleaning with Apco #42 solvent the armature assembly must be thoroughly dried out by placing it in a 115°-125° C. convection type oven from 3 to 6 hours.

NOTE: Drying will not be necessary after cleaning if a dry cleaning process has been used, unless megohm-meter check should so warrant.

Insulation Resistance And High Potential Test

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

When armature passes the megohmmeter test, apply a high potential test at 3200 volts at ambient temperature. If armature fails on high potential test and the ground or short is located in one of the upper armature coils and the armature is otherwise sound, the top section of that coil can be raised out of the core slot and a new

ground insulation (or cell) should be applied. If ground or shorts are located in bottom section of coil or cannot be located, the armature must be stripped and rewound.

When the armature passes high potential test, apply a bar-to-bar resistance comparison test (ductor test) with a low resistance ohmmeter test set. If the test indicates resistance readings are 10% or more above normal on 20 or more connections, hand solder all coil leads to commutator neck connections.

If test indicates resistance readings of 1/2% or more below normal, this will indicate a short which must be eliminated, or the armature must be stripped and rewound.

After soldering and clearing of shorts, apply a second ductor test to insure that the faults have been corrected.

Vacuum Impregnating Armature

Armatures which pass the above electrical test should be varnish treated using varnish 8316868 thinned with Xylol 8089758 to maintain viscosity at 45 to 62 seconds Ford Cup #4 at 21.1° C. The vacuum impregnation should be performed as follows:

1. Clean core section thoroughly with Xylol or petroleum solvent and wipe dry with a clean dry cloth.
2. Preheat armature until average core temperature stabilizes at 125° C. $\pm 5^\circ$. Be sure oven temperature does not exceed 175° C. at any time.
3. Remove armature from oven and place in vacuum impregnation tank. Do not allow armature to cool below 110° C. before placing it in tank.
4. Apply 28" to 30" vacuum to tank for 15 minutes.

5. With vacuum still on tank, run varnish into tank to level of commutator riser. If varnish tends to boil, bleed in small amount of CO₂ until boiling stops. Do not, however, open release valve to permit entry of atmospheric air. When varnish reaches proper level, apply 30 to 40 lbs. CO₂ pressure for at least 15 minutes.

6. After 15 minutes reduce CO₂ pressure to 10 - 12 lbs. and run varnish out of vacuum tank into a storage tank.

7. Apply 28" to 30" vacuum immediately and hold for 30 minutes.

8. Remove armature from impregnation tank and place in convection oven.

9. After average core temperature reaches 155° C. bake for 9 hours being careful that the oven temperature does not exceed 175° C.

10. Within 15 minutes after baking, tighten commutator bolts to 300 ft. lbs. and tack weld in place.

NOTE: Commutator bolts should not be tightened or disturbed unless major work has been performed on the armature such as coil replacement, resolder, etc.

High Potential Test On Armature

While armature is still hot, 50° C. $\pm 10^\circ$, apply a high potential ground test at 2400 volts for one minute.

Armature Shaft

Magnaflux armature shaft for circumferential and longitudinal cracks. If any are found, the shaft must be replaced.

Production tolerance for armature shaft bearing seat diameter is 5.1197" $\pm .0000$ " - .0005".

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.

ARMATURE BEARING INSPECTION

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

Cleaning

Before attempting to make any inspection, a bearing must be thoroughly cleaned. A mixture of 50% carbon tetrachloride and 50% benzine has been found suitable for this purpose. After inspection, bearings should be dipped in hot oil to prevent corrosion unless they are to be used immediately. A good grade of bearing oil should be used, or grease that is used for its lubrication in service.

Wear

A properly lubricated bearing not subjected to misalignment, dirt or distortion will show no evidence of wear. The internal radial clearance of the bearing may be checked by passing a feeler gauge between the rollers and race on the unloaded side. Do not roll a feeler through a bearing. For limits see Maintenance Data.

Fatigue Failure

Sign of bearing fatigue will most usually appear on the bearing surface. Fatigue failure is usually evidenced as ragged craters, and may be of any size. Any bearing showing signs of cracks or craters of any size, regardless of how small they may be, should be replaced.

This type of failure is more likely to occur on either the rollers or inner race.

Dents

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

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

Scratches

In general, scratches due to mishandling are not serious provided they are small. Scratches on the bearing surface, parallel to the length of the bearing are more

serious than those at an angle. Sometimes, scratches are difficult to differentiate from cracks, and for this reason, if there is any doubt as to their character, they should be treated as cracks due to fatigue failure.

Heat

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

Cages

Bearing cages which show excessive wear should be replaced.

Honing

When it is necessary to free up the fit of the bearing, a hone should be used in the housing. An inside and outside micrometer should be used for checking the bearing and the housing dimensions.

ARMATURE BEARING ASSEMBLY

Before shrinking armature bearing to shaft, it is very important that the bearing be tried in its housing before assembly. Place bearing housing on floor and try bearing through bore of housing. Care must be taken to see that the bearing enters the housing bore squarely and is not cocked. If the outer race is tight, then it is necessary that housing bore be honed to give a push fit having a clearance from .002" to .003".

If a new armature bearing and housing are to be applied, it may be necessary at assembly to hone the housing bore to obtain the recommended .002" to .003" clearance between housing bore and bearing race. If a bearing race were at the maximum allowable tolerance, and the housing bore at the minimum allowable tolerance, the recommended clearance would not prevail. See Maintenance Data for bearing dimensions and tolerances.

Armature Bearing And End Housing Assembly To Shaft

1. Remove old grease from bearing cap and cover. Clean bearing cap and cover. Repaint with crankcase paint and allow to dry.
2. Apply an unweighed amount of grease, same type as specified in the Grease Chart at the end of this M.I., into the bearing cap and cover grooves.
3. Fill the lower portion of the bearing cap and cover with the type and quantity of grease as shown in the Maintenance Data. Grease cavity should be filled 180° to 200° for additive bearings, and 240° to 270° for sealed bearings, refer to Fig. 23.
4. Clean armature shaft and remove burrs or gall marks. Place bearing cap on shaft.
5. Heat the inner oil thrower in an oil bath or electric oven for half an hour at 248° F. or 120° C. If an induction heater is used, only heat up to 248° F. or 120° C. If an oil bath is used for heating, remove the oil from the oil thrower with clean bound edge cloths prior to shrinking to the shaft. When using an induction heater, pyrometer readings (with current off) should be taken periodically. After heating,

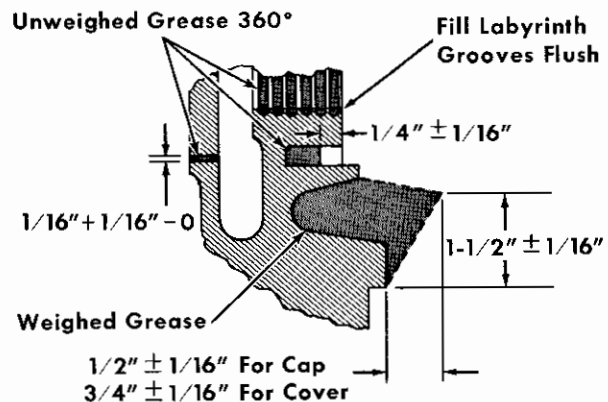


Fig. 23 — Application Of Grease To Cap And Bearing

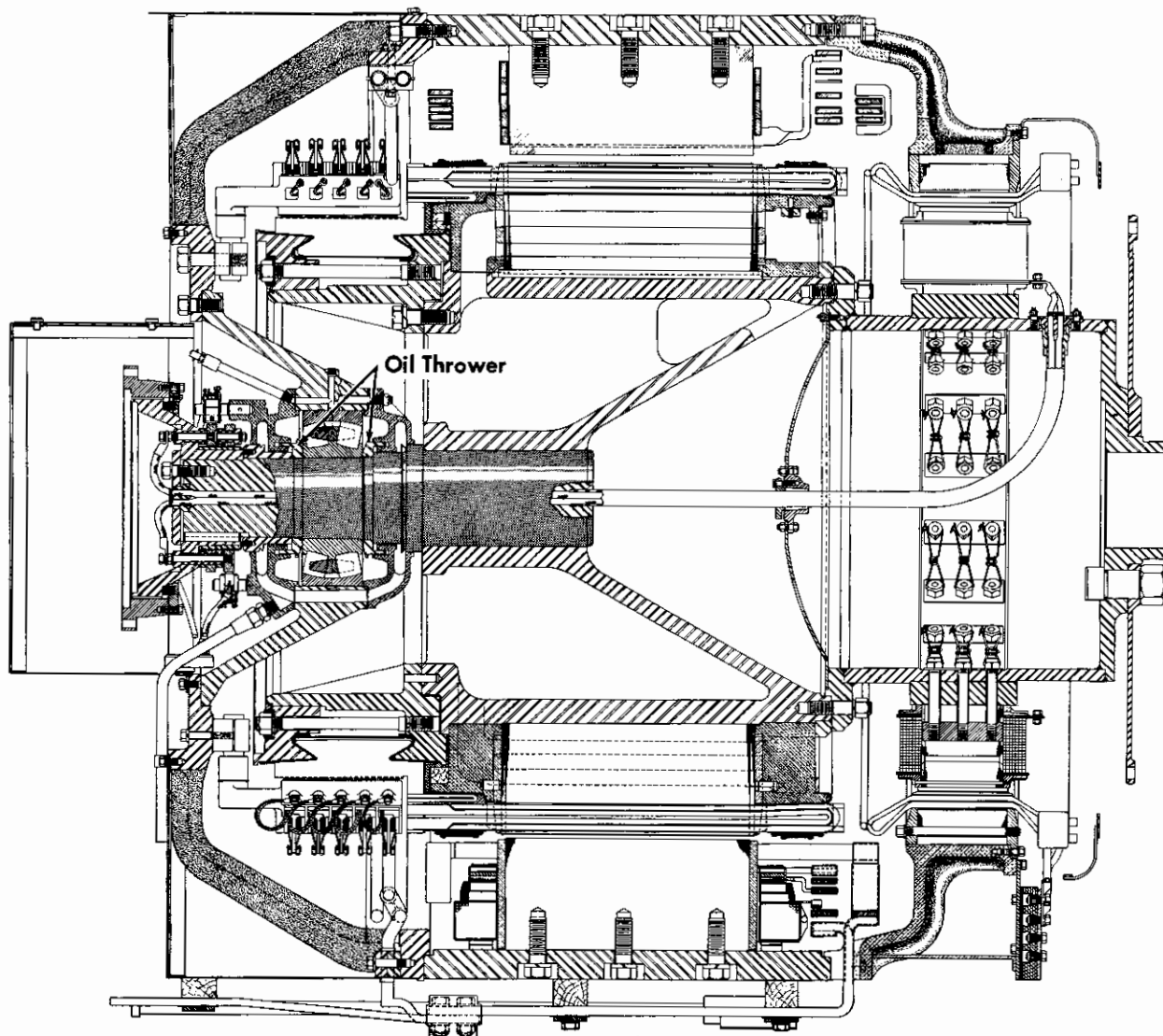


Fig. 24 — Cross-Section Of D12 And D22 Generator

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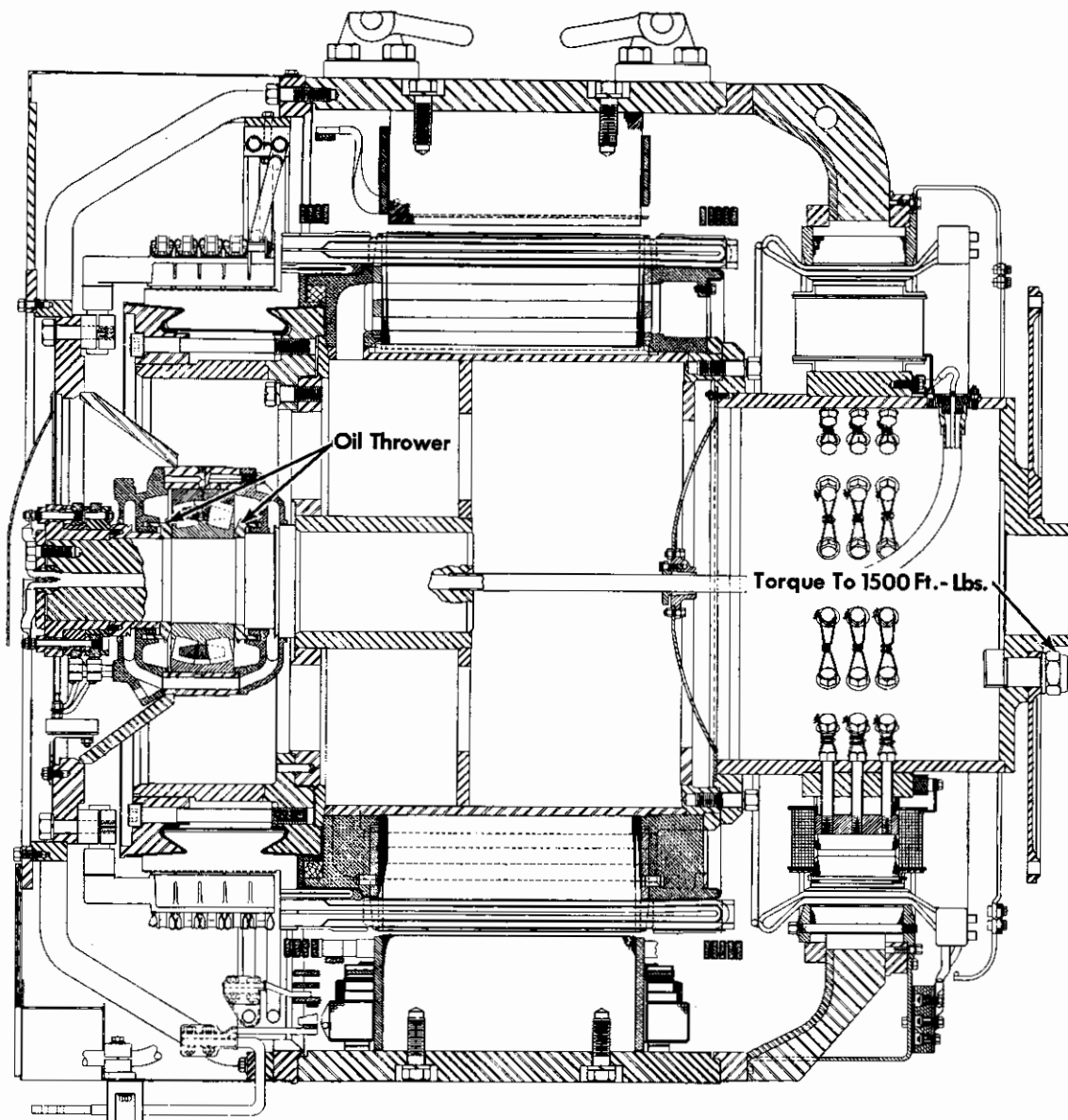
shrink the oil thrower to the shaft. See Fig. 24 and 25 for proper position on shaft. Let the oil thrower cool to room temperature.

NOTE: Care should be used when heating bearing assembly parts. Overheating may result in warping or metallurgical upsetting of the parts.

6. Pack the bearing rollers and the space between the two rows of rollers completely with the quantity and type of grease specified in the Grease Chart.
7. Heat roller bearing with an induction heater to 248° F. or 120° C. Take

pyrometer readings (with current off) at outside face of inner race only. Also, see note in Step 5. Shrink bearing to shaft with the bearing part number toward the outside. Do not cock the bearing when placing it on shaft. Use a brass pipe to push bearing on shaft up to and against inner oil thrower. Let bearing cool to room temperature.

8. Check the runout of the bearing inner race. Runout should be within 0.002" total indicator reading.
9. Apply two studs 8159226, Fig. 26, 180° apart to the 1/2"-20 N.F. 3 thread



12678

Fig. 25 — Cross-Section Of D32 Generator

- spline nut which is pressed into the bearing cap. Purpose of studs is to guide the bearing housing to the bearing cap. Before applying housing be sure to apply 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.
10. Heat the outer oil thrower in an oil bath or electric oven for half an hour at 248° F. or 120° C. If an induction heater is used, heat up to 248° F. or 120° C. Then proceed as per Step 5.
 11. Clean bearing housing bore with APCO and apply Molykote M88,8168822 with a brush or spray; allow to dry. Place aligning tool 8159227 on the shaft, Fig. 26, to hold the bearing outer race stationary and to assist in placing the end housing over roller bearing. If the bearing is an additive type, fill grease pipe and grease grooves in housing and housing core with recommended grease. For sealed bearings, fill grease grooves and holes in bearing and bearing housing. Install metal tag with screws near top of cover to read "DO NOT GREASE." Apply end

housing over the bearing, aligning the housing drain with the cap drain.

12. Fill the outer bearing cover pocket with grease around the lower 180° to the level indicated by Fig. 23. For additive type bearings fill the lubricating tube with grease and apply to the cover. Apply a new gasket to the housing. Then bolt the bearing cover to the end housing lining up the cover drain hole with the housing drain hole. Remove the two studs used previously for aligning assembly parts.
13. Heat armature shaft sleeve on induction heater to 260° F., or 127° C., and shrink to shaft.
14. Install alternator brush holder assemblies on posts pressed in bearing cover. Set brush holder assemblies so that a 1/8" clearance is obtained between bottom of each brush holder and slip ring.
15. Measure spring tension with the spring 1/8" above top of brush holder, should be 1-1/2 to 1-3/4 pounds.

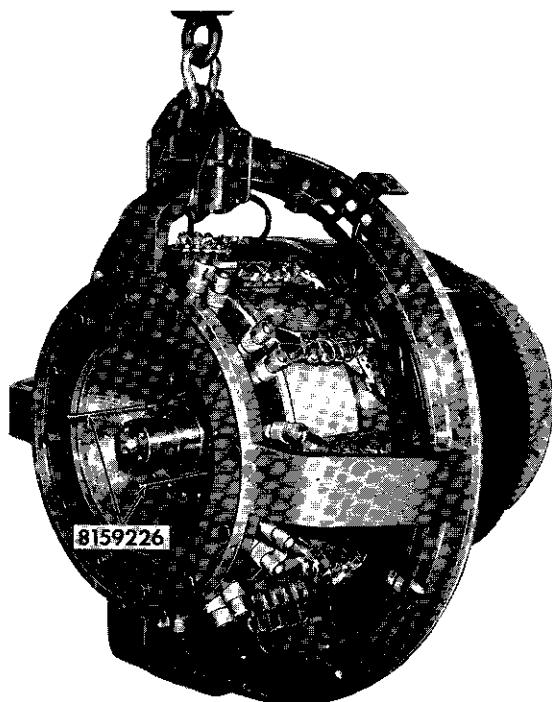


Fig. 26 — Applying End Housing To Armature Assembly

NOTE: Care must be exercised in measuring the spring tension because of spring and finger friction. Two methods may be used to eliminate friction.

- a. Wiggle the finger and spring while holding the tension scale in place.
 - b. Take an average of readings obtained while raising and lowering fingers with tension scale.
16. Install brushes in brush holders.
 17. Place alternator collector ring assembly on induction heater to expand bore. Heat to 248° F., or 120° C., taking pyrometer readings on slip rings. Clean keyway and assemble key to shaft. Shrink collector ring assembly to shaft. For position of assembly on shaft see Fig. 24.
 18. On generators which drive compressors, apply compressor coupling to collector ring and bolt in place.
 19. Assemble conduit bushing on cables and insert into end of shaft. Bolt shaft flange to end of shaft.
 20. If new cables are used, cut and skin to allow enough slack in cables to clear bolt heads. Solder terminal lugs to cables.
 21. Apply 5/8" loom insulation over cable 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 insulating enamel.
 22. Connect drain pipe to bearing cover and bolt with pipe clamp to end housing.

GENERATOR-ALTERNATOR ASSEMBLY

1. If alternator rotor assembly was removed from generator rotor, bolt

127 17

these two assemblies together using sixteen 7/8" - 9 bolts tightened to a torque value of 375 to 400 ft-lbs.

2. Bolt alternator stator assembly to generator stator frame.
3. Apply coupling disc to alternator rotor hub using six 1-1/2" - 12 "D" head bolts with hardened washers and self locking nuts and torque to 1500 ft-lbs. Any D12 or D22 generator using the old style bolt and nut should be torqued to 1200 ft-lbs.

NOTE: On D12 and D22 generators if the new self locking nut is replacing an old style nut the rotor hub diameter must be machined from 7-3/8" to 7" to allow clearance for the new nut.

4. Place generator stator assembly and armature 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 spider, the end of the arbor fixture protrudes through the stator assembly as shown in Fig. 27.
5. Using two wire cable loops, place one loop through the generator end housing and the other loop around the arbor fixture. With the aid of two cranes, lift and guide the armature and alternator assembly into the stator assembly as shown in Fig. 27. Guide the armature assembly slowly and carefully so as not to damage the coils or insulation. Install bolts through end housing to frame and torque to 200 ft-lbs.
6. Place fish paper strips 1/16" x 3" x 36" in air gap between armature and field poles. Do not apply any fish paper or other material in air gap between

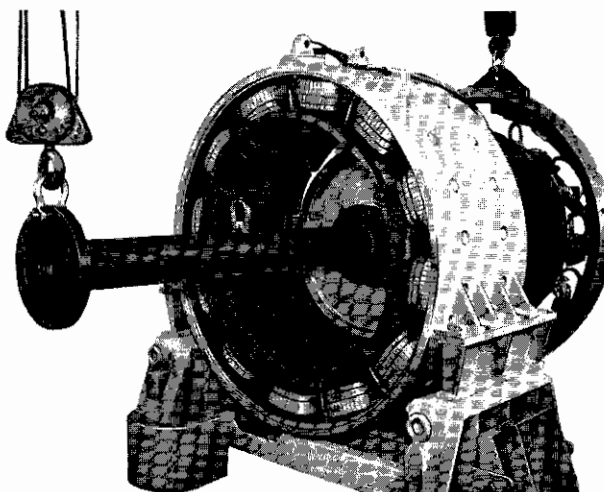


Fig. 27 — Installing Armature
Into Stator

alternator rotor and stator. Remove wire cable loops and arbor fixture after fish paper has been applied.

7. Install split brushes, and bolt shunts from brushes to brush holder. Make sure brushes are properly seated. With a clean, dry, lintless, bound edge cloth, clean carbon dust from commutator riser, string band and porcelain insulators.
8. Prior to assembly of bus bar, bar must be 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 to the bus which ties in the compensating and differential field connections. After tightening all bolted 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 connection with red air-drying enamel.
9. Attach bus bar to generator frame by inserting molded cleat (8325547 for D32 and 8325548 for D12 and D22) under bus bar. Place molded clamp

(8325549 for D32 and 8325550 for D12 and D22) over bus bar and bolt assembly to generator frame.

NOTE: If old style clamp 8081905 is used with wood block 8084159 under bus bar, use phenolic block 8092355 as insulator between bus bar and metal clamp.

10. Apply air box assembly and commutator covers.
11. Apply compressor coupling guard assembly, if applicable, and bolt in place. Connect collector ring brush holder cables to terminal block on guard assembly.

CAUTION: Connect the cable leads from brush holders of same polarity to the same terminal post, otherwise the rotor field will be short circuited and a direct short circuit placed on the auxiliary generator.

HIGH POTENTIAL TEST

Refer to Maintenance Instruction 6800 for testing the generator in the locomotive.

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

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

Generator 950 volts
High voltage wiring and high
voltage equipment 1050 volts

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

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 the utmost importance that a reliable high potential tester be used, to insure that an adequate test is made and also unnecessary over-stressing of insulation does not take place. In regard to the features which should be incorporated in a high potential tester, the following points are pertinent:
 - a. Wave form
 - b. Surges
 - c. Voltage regulation
3. In making high potential tests, extreme care should be taken to see that every person is in the clear before applying the voltages.
4. When testing Electro-Motive armatures individually, strap around the commutator with bare wire, before applying high potential tests.

SHIPPING GENERATOR-ALTERNATOR

It is absolutely necessary that the armature be blocked under a stub shaft fixture placed in the alternator rotor spider to

relieve the weight on the field poles, and fibre pieces should be inserted in the air gap of the generator to prevent damage during shipment. Each generator shipped from Electro-Motive has a skid and supporting jack. Generators shipped back to Electro-Motive should be returned on this skid and jack. The compressor coupling guard, if applicable, should be removed from the outgoing generator and reassembled on the incoming generator, as generator is shipped complete less coupling guard assembly. Drawing 8107436 may be obtained on request as an aid in shipping of generator.

INSTALLATION OF MAIN GENERATOR-ALTERNATOR IN LOCOMOTIVE UNIT

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

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

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

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

Apply a 2-3/8" socket wrench to the engine to generator coupling bolt nuts to make sure they are tightened to 1500 ft-lbs. Any generators using the old style 2-3/16" nuts must be torqued to 1200 ft-lbs.

Inspect and clean shims. Shims must be smooth, free from burrs and kinks. Shims should have been tagged after removal

of generator so they may be installed in their original position at this time.

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

Line up hole patterns in the engine and generator coupling discs by barring or jacking engine over. Push generator toward engine until its coupling fits into the bevelled 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 generator coupling disc and engine coupling disc from the engine side. Check to be sure the generator disc 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 or fibre strips are removed from between armature and field coils. There should be no fish paper under the alternator field coils.

Line up dowel holes and install base bolts. Do not insert dowels or base bolts until generator is aligned with engine.

ALIGNING GENERATOR WITH ENGINE

The alignment of generator with engine is divided into three operations:

1. Thrust — Finding the longitudinal position of armature with respect to the frame or aligning generator bearing in housing.

Operations No. 2 and No. 3 are carried out simultaneously.

2. Angular — Neutralizing the angularity of generator to engine coupling.
3. Radial — Balancing and setting the air gap between the generator armature and the field poles.

Aligning Generator Bearing

After generator is coupled to engine, it is very important to locate the generator frame so as to have the single bearing at the commutator end located axially in such a way as to avoid a thrust load in either direction. The generator has a bearing float of about $5/16$ " between the bearing cap and cover in bearing housing. This bearing float (end play) is stamped on bearing cover at lubricating tube. The bearing in the generator housing must be spaced as shown in Fig. 28.

1. Remove one oil pan handhole cover and take out all the crankshaft thrust by prying against a crankshaft web and crankcase. Move all crankshaft thrust toward generator end of engine.
2. Next, locate a measurement number stamped with $1/2$ " numbers on top of right horizontal rib of end bell.

NOTE: Measurement "X" should be used for aligning generator bearing as explained in text.

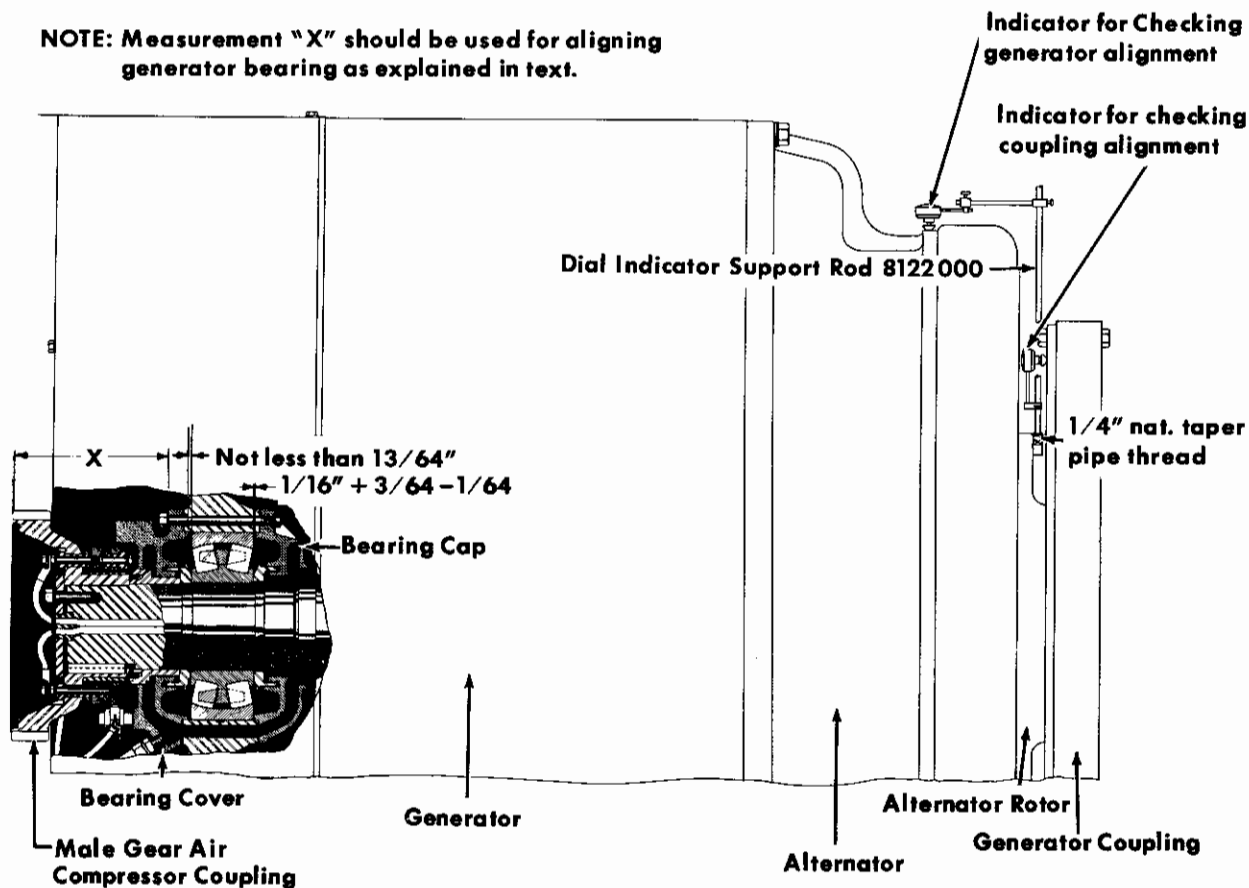


Fig. 28 — Generator Bearing To Housing Alignment

- a. On locomotives having gear type generator-compressor coupling, this stamped number is the measurement in inches from top right spot-faced surface of the bearing cover to outer end surface of the male compressor coupling gear mounted on generator shaft. This measurement "X" Fig. 28, is about 9" when armature bearing in generator housing is flush with inside of the bearing cap.
- b. On locomotives having a Falk type generator-compressor coupling, this measurement "X" is taken from top right spot-faced surface of the outer bearing cover to outer end surface of compressor-coupling adapter mounted on the generator shaft and is about $7-15/32$ ".
- c. The measurement "X" on generators not having coupling gear or

Falk coupling adapter (not coupled to compressor when installed in locomotive) is taken from top right spot-faced surface of outer bearing cover to outer end surface of alternator slip ring hub and is about 5-19/32".

NOTE: The measurement stamped on end bell is determined during final generator assembly with the armature purposely positioned so that its end play is all taken up in the direction of the engine coupling.

3. Depending upon the application in the individual locomotive, make a measurement as listed under a, b, or c of Item 2. Move generator frame in either direction away from or toward the engine to obtain a measurement which will be $1/16" + 3/64" - 1/64"$ greater than the figure stamped on generator end bell.

Alignment Procedure

The proper operation of the power plant requires that the generator armature shaft and generator frame be in line with engine crankshaft, and that the air gap be equally spaced. It is equally important that eccentricity at the coupling be held to a minimum as this directly affects balance, brush and bearing wear.

The air gap of the generator must be uniform within plus or minus .010" from average under each main pole, as well as under each commutating pole and also from the front to rear of each pole to obtain the proper electrical characteristics of the generator.

Since the generator has only one roller bearing, the recommended method for aligning the air gap and coupling is at the engine end of the generator.

The aligning procedure is divided into two operations, both of which are carried

out simultaneously: (a) neutralizing the angular misalignment of the generator to engine coupling, (b) balancing and setting the air gap between the generator armature and the field poles.

1. By means of two dial indicators mounted on a support rod 8122000, which is screwed into a tapped 1/4" pipe thread hole in the D14 alternator field spider, a measurement of the coupling misalignment and generator air gap variation is determined. Both indicators revolve with the armature shaft. The plunger of one indicator rides on the outside machined diameter of the alternator aluminum housing at the joint where the stator winding guard connects to the housing, see Fig. 28.
2. With the engine turning jack assembly, the flywheel should be turned so that the indicator rod is in a vertical position. This will place both indicators near the top of the alternator housing.
3. After clamping the indicators on the rod, the plunger buttons of the indicators are brought to bear upon the surfaces as shown in Fig. 28. In setting the indicator, depress the plunger until the pointer makes one complete revolution or .100". There being .200" total revolving travel to the indicator pointer, there still is .100" plus left to work with, and the plunger can back out to show minus reading for total of .100".
4. With the indicator set, turn the flywheel, with engine jack, one-half revolution in a clockwise direction, when facing commutator of generator; then rotate the flywheel three-quarters of a revolution in a counter-clockwise direction. (The reason for the counter-clockwise rotation instead of continued clockwise rotation is to prevent the indicators from striking

the alternator terminal board). From the three-quarter counter-clockwise position, return the indicators to the starting point and check registration on indicators. The pointer must return to zero, if not, reset indicators and make another check or replace indicators, if defective.

5. From this fixed point, revolve the flywheel a half revolution (180°) in a clockwise direction (when facing the commutator end of the generator) and record the readings at the 90° and 180° points when rotating in this direction.
6. From the 180° point in Step 5 revolve the flywheel three-quarters of a revolution in a counter-clockwise direction and record the indicator reading at this point. Return the dial indicators back to the original starting or fixed point. Indicators must then register zero.
7. The generator is considered to be aligned when readings are obtained as shown in Fig. 29. Torque engine to generator $3/4''$ -16 bolts to 295 ft-lbs.

Since any movement of the generator frame affects both the coupling and air gap, readings must be repeated for both after each setting. Experience will indicate the proper shim thickness to bring the readings within the limits specified. Full length shims should be used when

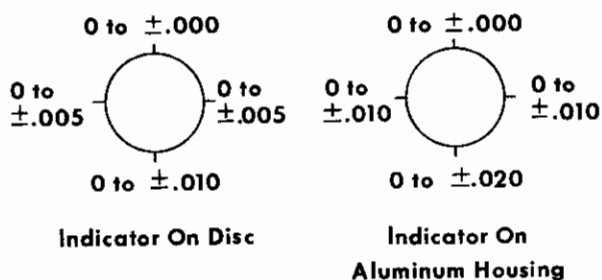


Fig. 29 — Generator To Engine Coupling Alignment

possible, although spot shims may be necessary to conform to the limits specified for the air gap and coupling.

After installation of a new generator and upon completion of line-up with the engine, run the power plant for a short time before the locomotive is moved. This will allow the generator to settle so that when the dowels are installed there will be no further run-in necessary.

Install generator to underframe dowels. Torque generator hold down bolts to 1200 ft-lbs and secure bolts with lock plates.

Air Compressor Drive Alignment With Gear Type Main Generator Coupling

To align air compressor coupling flange to main generator gear drive proceed as follows:

1. Disconnect coupling by removing bolts attaching compressor ring gear to compressor flange, see Fig. 30.
2. Slide compressor ring gear toward generator to clear front face of compressor gear assembly teeth.
3. In order to avoid overcompression of felt washers, the compressor must first be located to give a clearance dimension of $7/32'' \pm 1/32''$ between the pilot face of compressor flange and front face of the generator-to-compressor coupling gear assembly. End play in the compressor shaft need not be taken into consideration when locating compressor to obtain the $7/32''$ clearance, as normally there is but $.010''$ end play with the compressor cold.
4. A dial indicator support rod 8133046, Fig. 30, for holding the dial indicators is fastened to one of the three $1/2''$ standard threaded holes of the compressor coupling gear on the generator shaft, and extends horizontally through one of the three $2''$ diameter holes in the compressor flange.

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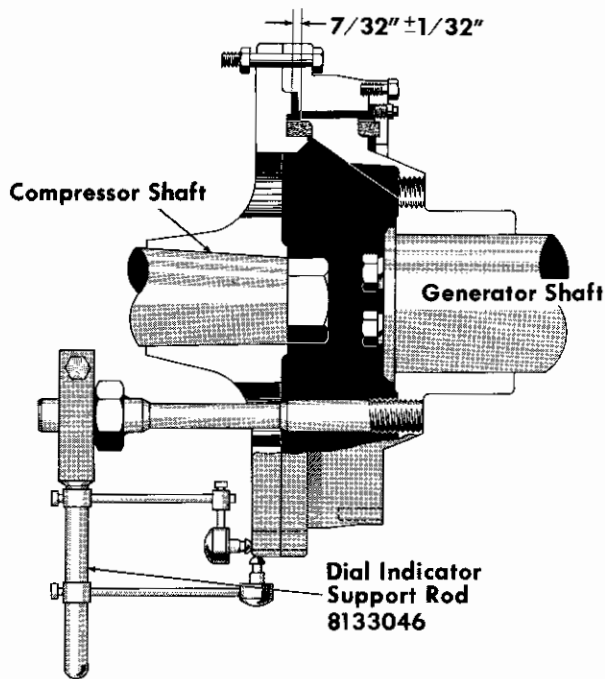


Fig. 30 — Air Compressor And Generator Alignment

Attach two dial indicators to the tool post. The button of one indicator rides the outer rim of the compressor flange to check radial alignment; the button of the other indicator rides the face of the compressor flange, toward the compressor, to check the angular alignment.

5. Rotate generator shaft and compressor shaft together, either by rotating each the same amount, or by tying the two units together in such a way that compressor alignment will not be affected. The two units can be tied together by a loose fitting bolt through the 1/2" holes in the compressor flange and the compressor ring gear.
6. Radial runout should not exceed .005" total indicator reading. Total runout between generator gear face and compressor flange face should not exceed .010".
7. Before reassembling, the surface of the coupling gear teeth should be coated generously with a N.L.G.I. (National Lubricating Grease Institute) grease of #3 consistency containing 13 to 15% sodium base soap. Further lubrication should not be necessary until unit is disassembled for overhaul. This coupling is normally noisy due to built-in gear lash. The introduction of lubricant under high pressure is not approved, as there is danger of rupturing the felt seals, thus allowing lubricant to flow over alternator slip rings and brushes.

MAINTENANCE DATA

SPECIFICATIONS

Weights

Generator (complete-without sheet iron housing)	17,710 lbs.
DC Armature	6,246 lbs.
AC Rotor	1,400 lbs.
Generator field assembly	7,130 lbs.
AC Stator (complete)	930 lbs.

Nominal Air Gap (under)

Main poles . . . . .	.1535"
Commutating poles . . . . .	.328"

Brush Holder

Number of brush arms	12
Clearance between brush holder and commutator	1/8" + 1/16" - 0"

Brushes

Number of brushes per arm	5 sets (split)
Size of brush	
Adjustable pressure brush holder	5/8" × 1-5/16" × 2-9/16" (long side) (5/8" made up of two brushes)
Constant pressure brush holder (8331071)	27/32" × 1-5/16" × 2-9/16" (long side) (27/32" made up of two brushes)
Wear Limit - Adjustable pressure brush holder	1-9/16" (long side)
Constant pressure brush holder	1-1/8" (long side)
Grade	DE8
Type	Split
Spring tension	
Adjustable pressure brush holder	4 to 4-1/2 lbs.
(low limit with worn brush)	3-1/2 lbs.
Constant pressure brush holder (8331071)	3.28 lbs.
Commutator	
Minimum diameter	34-1/4"
Neck width (minimum)	3/4"
Mica groove depth	3/64" to 5/64"
Mica groove width .....	.030"

Resistance at 75° C.

D32 Generator

Armature .....	.00260 to .00270 ohms
Armature (1-10) .....	.00174 to .00191 ohms
Main Circuit A-D .....	.00445 to .00463 ohms
Interpole A-B .....	.00221 to .00230 ohms
A-E .....	.00221 to .00231 ohms
Differential Field C-D .....	.00136 to .00142 ohms
D-F .....	.00137 to .00142 ohms
Compensating Field E-F .....	.00348 to .00362 ohms
B-C .....	.00350 to .00366 ohms
Starting Field .....	.00572 to .00596 ohms
Shunt Field	91.78 to 94.48 ohms
Battery Field	1.15 to 1.22 ohms

D22 And D12 Generators

Armature .....	.00306 to .00318 ohms
Armature (1-10) .....	.00204 to .00212 ohms
Main Circuit A-D .....	.00480 to .00498 ohms
Interpole A-B .....	.00220 to .00229 ohms
A-E .....	.00222 to .00231 ohms
Differential Field B-C .....	.00140 to .00146 ohms
F-D .....	.00140 to .00146 ohms
Compensating Field E-F .....	.00393 to .00409 ohms
C-D .....	.00396 to .00412 ohms
Starting Field .....	.00560 to .00583 ohms
Shunt Field	91.2 to 95.8 ohms
Battery Field	1.15 to 1.22 ohms

D14 Alternator

Alternator Rotor	
(Slip ring to slip ring)	2.13 to 2.29 ohms
Alternator Stator	
(Phase to phase) . . . . .	.00965 to .01045 ohms
Maximum allowable variation	
between any 2 phases . . . . .	.0001 ohms

Roller Bearing

Outer diameter	11.0236"	+ .000"	- .0014"
Bearing bore	5.1181"	+ .000"	- .001"
Width	3.661"	+ .000"	- .005"
Internal clearance (before assembly) . . . . .	.0035" to .005"		
Internal clearance (after assembly) . . . . .	.002" min.		
Bearing Housing Bore Diameter	11.0244"	+ .001"	- .000"
End Play Clearance (After assembly in generator housing)	5/16"		

EQUIPMENT LIST

Grinder - Commutator	8052924
Scale - Brush tension testing	8068027
Saw - Undercutting (.030")	8085255
Rod - Dial indicator support	8122000
Rod - Dial indicator support	8133046
Abrasive - Flexible	
cleaning stone	8149435
Stud - Armature bearing align- ment - 1/2" x 18" long (two)	8159226
Guide - Armature bearing alignment	8159227
Puller - Manual - Main	
generator bearing	8168577
(Export only)	8213622
Adapter - Commutator	8195928
Stone - Finish grinding (1" x 2" x 5")	8201791
Stone - Brush seating	8204957
Blower - Vacuum cleaner	8210140
Bar - Alignment (for 8052924 grinder)	8210141
Collector - Dust	8210142
File Assembly - Commutator slot	8217141

GREASE CHART

Additive bearing*	
Bearing	13 oz. + 1/4 oz.
Cap	14 oz. + 1/4 oz.
Cover	14 oz. + 1/4 oz.
Sealed bearing**	
Bearing	14 oz. + 1/4 oz.
Cap	18 oz. + 1/4 oz.
Cover	18 oz. + 1/4 oz.
*Lubrico M6	8068104 (25 lbs.)
	8102808 (120 lbs.)
**Texaco Regal	
Starfax #2	8079816 (35 lbs.)
**Cyprina RA	
Grade 3	8249819 (35 lbs.)
	8249820 (120 lbs.)