EMD MAINTENANCE INSTRUCTION

MAIN GENERATORS AND GENERATOR-ALTERNATORS, TYPES D25 AND D15

DESCRIPTION

The Model D25 and D15 generators are very similar in appearance and construction. Alternator numbers have been added to the model numbers to designate generators equipped with alternator assemblies. Unless otherwise noted in this bulletin, the instructions contained will apply to several models containing the initial model numbers.

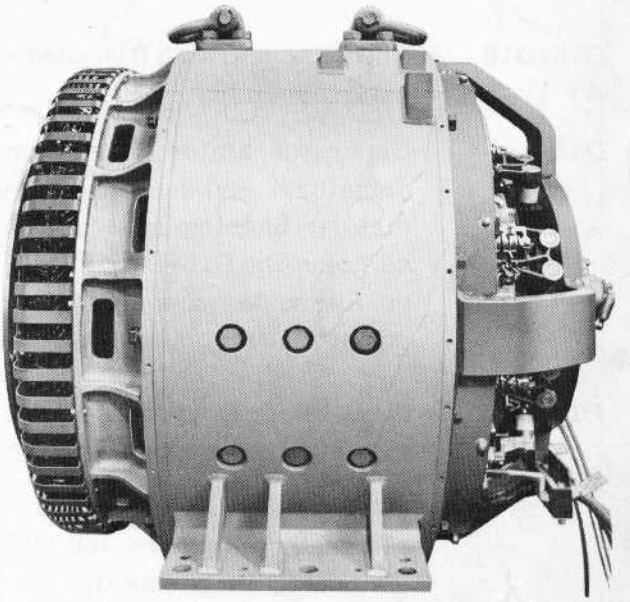

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Fig. 1 — Generator-Alternator Assembly

Models D15-D16, D15B-D16, and D25B-D16 main generators, Fig. 1, are equipped with alternators. These generator-alternator assemblies are directly connected to the diesel engine crankshaft through the alternator rotor spider and a flexible coupling. Models D15A, D15C, and D25C, Fig. 2, are directly connected to the diesel engine crankshaft through the generator armature spider and a flexible coupling.

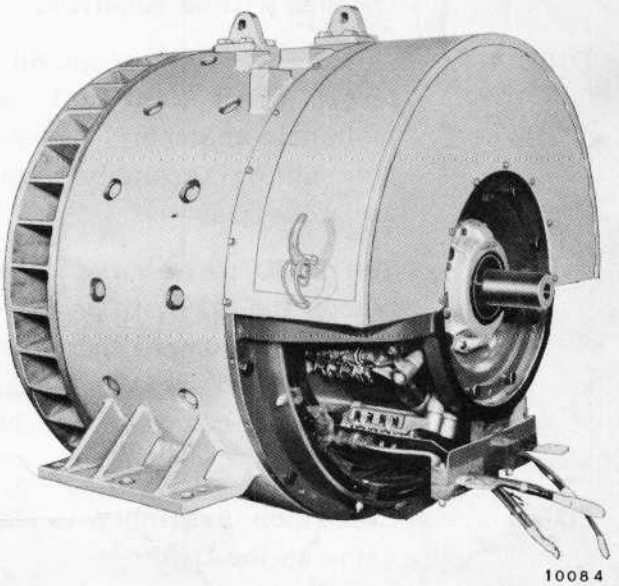

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Fig. 2 — Generator Assembly

Models D15-D16, D15B-D16, and D25B-D16 generator-alternators are force ventilated by a blower driven by the auxiliary generator. The commutator end of generator assembly is totally enclosed with the air box and the commutator cover assembly.

Ventilation for D15A, D15C, and D25C generators is provided by a fan mounted on the generator to engine coupling disc which draws air from the commutator end past the field coils and around the armature. Only the upper portion of the commutator end bell assembly is enclosed.

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

ELECTRO-MOTIVE DIVISION
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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.

Following are the main model differences between the generators:

D15-D16 - Built integral with D16 alternator assembly.

D15A - Generator stator, generator armature, end bell and armature bearing assemblies same as the D15-D16, except no alternator assembly and collector ring assembly.

D15B-D16 - Built integral with the Model D16 alternator assembly.

The D15B-D16 generator-alternator replaces the D15 generator in production locomotives, and when interchanged with D15, electrical changes will be required.

D15C - Same as D15A, except different shunt field coil on main pole assembly. Generator stator assembly same as D15B-D16.

The D15C generator replaces the D15A in production locomotives, and when interchanged with D15A, electrical changes will be required.

D25C - Generator assembly is the same as the D25.

D25B-D16 - Built integral with the Model D16 alternator assembly. The generator assembly is the same as the D25C.

Model D4 generators cannot be readily interchanged with D15A or D15C generators on locomotives using D4 generators built prior to January 1949, without making alterations.

GENERATOR FIELDS

The generator contains five 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, 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 control of the load regulator which serves to maintain a constant horsepower demand on the engine for any ampere demand within capacity of the generator.

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

MAINTENANCE

Electrical insulation gradually deteriorates or weakens under normal service from heat, dirt, moisture and age.

The rate at which insulation deteriorates therefore depends on the service and care to which it is subjected. The total useful life can be increased by keeping insulation clean and protecting it from moisture. Insulation can also be rejuvenated, or some of its original life restored, with periodic overhaul by thoroughly cleaning and vacuum impregnating. This process also protects 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. Electro-Motive however, recommends that the generators be overhauled with approved materials and by proper processing as often as outlined in Maintenance Instruction "Scheduled Maintenance Program." If proper equipment for overhaul is not available, the generator should be returned to the locomotive manufacturer whenever repair or overhaul 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 Maintenance Instruction "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 clean, dry, compressed air and dry cloths, a stiff brush or soft wooden or fibre scrapers may be required. If the commutator becomes oil sprayed, dampen a cloth in a solvent type cleaner to remove oil. However, every precaution should be taken to keep solvent off commutator and copper parts.

This type of cleaner should be used only when other methods fail to remove the foreign material.

After cleaning, and if necessary, the inside of the 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 Maintenance Instruction "Scheduled Maintenance Program." These inspections will insure operational efficiency and determine what maintenance is required to prevent failure in service. Specific inspection procedures for the generator 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 Maintenance Instruction, "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 is the approved lubricant. Bearing lubrication intervals are as specified in Maintenance Instruction, "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 any time cover or cap is removed and replaced.

BRUSH HOLDERS AND BRUSHES

A periodic inspection of brushes and brush holders, Fig. 3, should be made and the following points observed:

Brushes should move freely in the holders. Release the springs from anchor pin, and raise and lower the brushes in the carbonways so as 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.

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 tolerance.

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 degree, causing melting and throwing of solder. Brushes should be seated by idling the engine and using seating stone 8204957, Fig. 4. A 90% seat is satisfactory.

The brushes are staggered at the factory and this relative position should

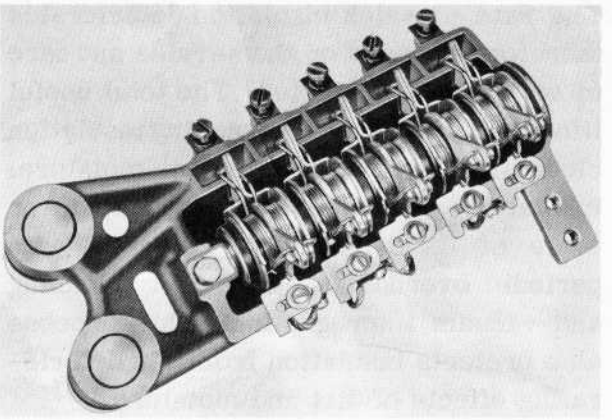

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Fig. 3 — Brush Holder Assembly

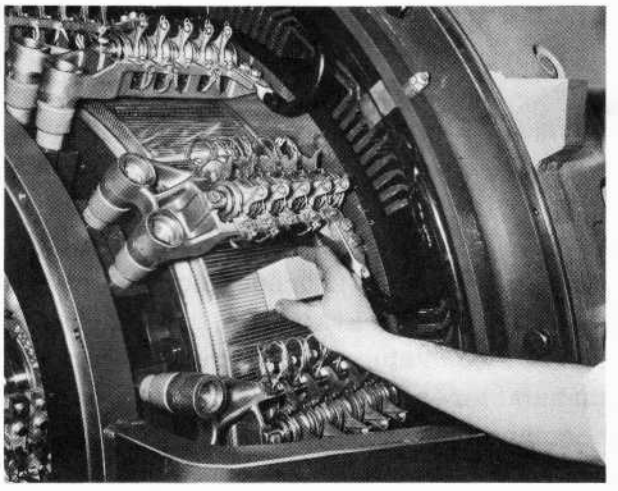

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Fig. 4 — Seating Brushes

be maintained to prevent grooving of the commutator. They are staggered in pairs, that is, the ends of the brushes in two adjacent brush holders should be in line, but should be out of line with the next pair of brush holders.

The proper brush pressure should be maintained as specified under "Maintenance Data." It is important that all the brushes be adjusted to the same pressure, as unequal brush pressure will cause unequal current distribution in the brushes. Measure the spring tension with lever arm 1/8" above top of the brush holder box. Refer to Fig. 5 for the method of measuring the brush pressure.

A 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 first or second 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 reduce friction, wiggle finger and spring while holding tension or take an average reading while raising and lowering fingers with tension scale.

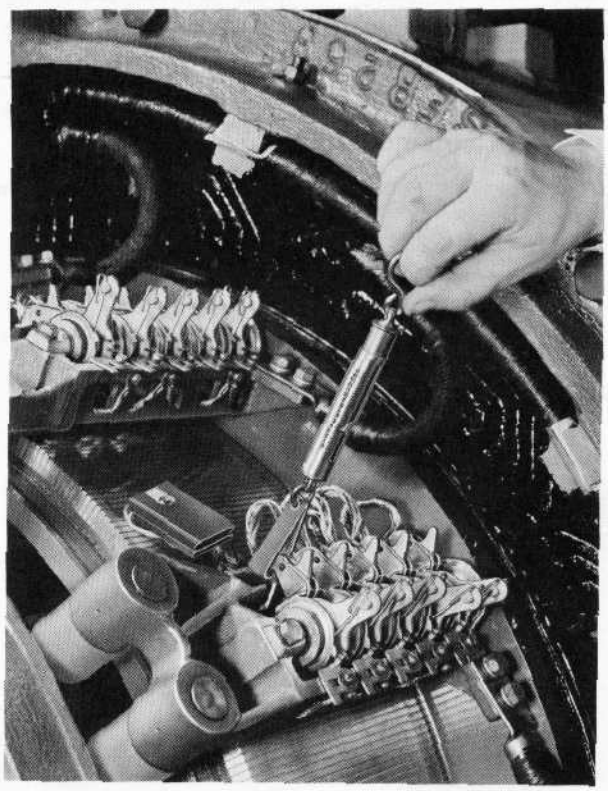

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Fig. 5 — Measuring Brush Spring Tension

BRUSH HOLDER STUDS

Keep brush holder stud insulation clean. Do not allow oil or dirt to accumulate on the 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 can not be cleaned. Replacing brush holders as an assembly, Fig. 3, reduces time required to replace or repair stud insulation (either the polyester type or porcelain insulators).

Polyester Glass Insulated Studs

The following procedures apply to brush holders equipped with polyester glass insulated studs, Fig. 6.

The polyester glass insulation is more durable than other types of brush holder insulator materials in that it is less susceptible to breakage and permanent carbon tracking. In the event a flashover occurs, this type of insulation can be put back in serviceable condition by polishing the surfaces with fine sandpaper.

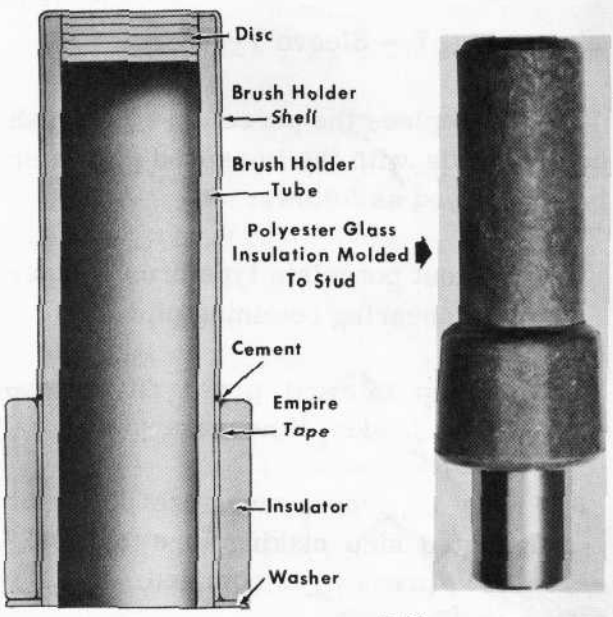

Fig. 6 — Brush Holder Studs

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

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 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. 7, should be used for pressing the polyester glass insulated studs into the brush holders.

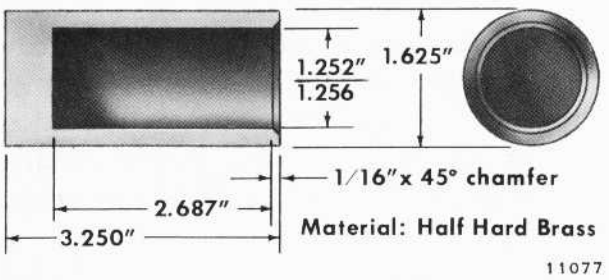

Fig. 7 — Sleeve Type Tool

To replace the porcelain type brush holder studs with the improved 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" $\pm$ .001" press fit is obtained.

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

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. 8.

Porcelain Stud Insulators

The following procedures apply to brush holders equipped with porcelain stud insulators, Fig. 6.

Inspect the porcelain insulators for cracks and holes through glazed surface. Check the tubes for looseness. If perforated, or if the tubes are loose, replace the insulator assembly. Inspect for cracked, broken or separated cement around the top of porcelain insulator.

When the tube is loose on the brush holder pin, the porcelain can be cracked to facilitate removal. The tube and shell are cut lengthwise with a saw and removed. Use caution so as not to damage brush holder pin. Replace the insulator as an assembly. Use collet over tube to prevent damage during pressing.

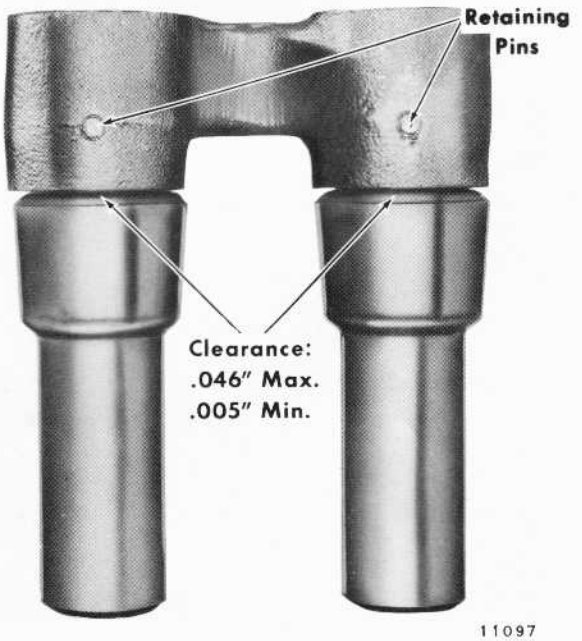

Fig. 8 — Polyester Studs Installed

If the tube is tight on the brush holder pin the porcelain insulators may be replaced individually provided the shell and insulator tube are in good condition.

When replacing porcelain insulators, the porcelain insulator should have a snug fit over the brush holder tube insulator. To accomplish this, cut a small length of Empire tape (.010" × 1-1/2") and wind the tape over tube insulator.

Apply porcelain insulator over the Empire tape and adjust length of tape to give porcelain insulator a snug fit over tape. Then apply clear baking varnish on tape and inside of porcelain insulator. Apply washer to upper side of insulator before pressing insulator and pin assembly into the brush holder. The washers and buildups of varnished Empire tape have eliminated the use of talc cement on porcelain insulators. If only the porcelain insulator is replaced, apply a high potential ground test to brush holder at 4200 volts for one minute.

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. Four 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. 9 to aid the installation of the assembly to the brush holder.
3. Apply clips to hold anchor assembly on brush holder and set spring tension as previously outlined.
4. Maintain 1/8" + 1/16" - 0" clearance between bottom of brush holder and commutator, Fig. 10. The brush rigging is arranged in such a way that brush holder may be moved toward commutator surface as the commutator wears or is turned, so as to maintain the 1/8" + 1/16" - 0" clearance between the face of brush holders and

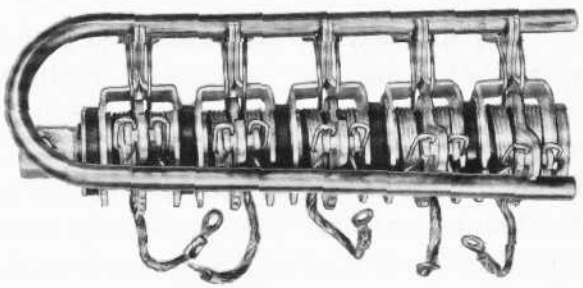

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Fig. 9 — Lever And Shaft Assembly "U" Tool

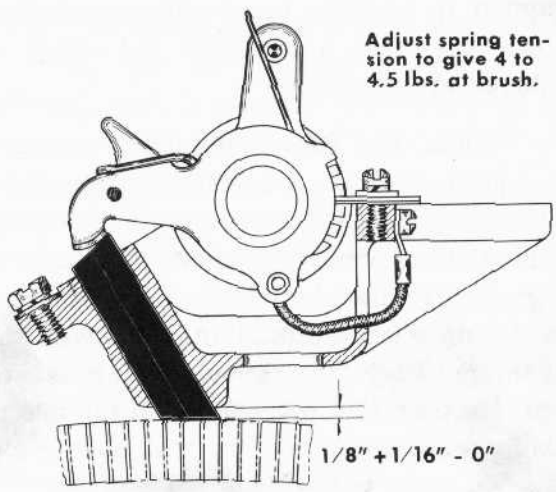

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Fig. 10 — Brush Holder Clearance

commutator. Brush holders should be kept bolted rigidly in place.

5. Care must be taken, when brush holders are removed or replaced, that the cutting from the lock washer does not fall on the commutator and become lost among the other brush holders or brushes.

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 megohmmeter 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 will have to be uncoupled from the engine and the complete generator or generator-alternator assembly removed from the unit and placed on the shop floor. Before removing the generator or generator-alternator assembly from the locomotive, place fish paper strips (1/16" × 3" × 36") in the air gap between the armature and field poles of the direct current generator. Remove brushes from commutator and collector rings and protect commutator surface with a fish paper wrapping. Raise assembly from the shop floor by blocking under generator mounting plates.

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. Remove excess varnish from points of measurement. Obtain a pole spacing measurement between the side of the adjacent interpole cores, and record this measurement. These measurements will be of aid in alignment of poles when reinstalling new poles.

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

Clean pole core and frame contact surfaces before assembling pole assembly to stator frame.

Before soldering connector straps or cable connectors, align the generator pole spacing as follows:

1. The pole spacing between the side of the interpole core and the adjacent side of the lead end of the main pole core has a nominal spacing of 1-43/64"; and between the side of the interpole core and the adjacent side of the trailing end of the main pole the nominal spacing is 1-3/4". 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 .020" of the average interpole air gap of that machine.

3. Every main pole air gap on any one machine shall be within plus or minus .014" of the average main pole air gap of that machine, with air gap readings taken at the center line of poles.

4. Center line of poles should not vary from nominal center line more than 1/32".

All connector joints other than interpoles, shunt field, battery field and compensating field connectors are soldered with Hi-Temp solder 8004399. Battery and compensating field connectors are soldered with tin base solder 8004402. (Flux with Nokorode 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 field conductors when performing any of the soldering operations.

Fig. 11 shows a generator field assembly.

Electrical Inspection

After cleaning and drying but before any work has been performed, it is recommended that this test be made as follows:

1. Apply an insulation resistance test to the stator. It should have a minimum of not less than 2 megohms. If it tests 2 megohms or better a high potential test of 1050 volts should be given.

NOTE: When applying high potential test to main circuits, ground battery and shunt field circuits.

When applying test to shunt field, ground both leads of battery field.

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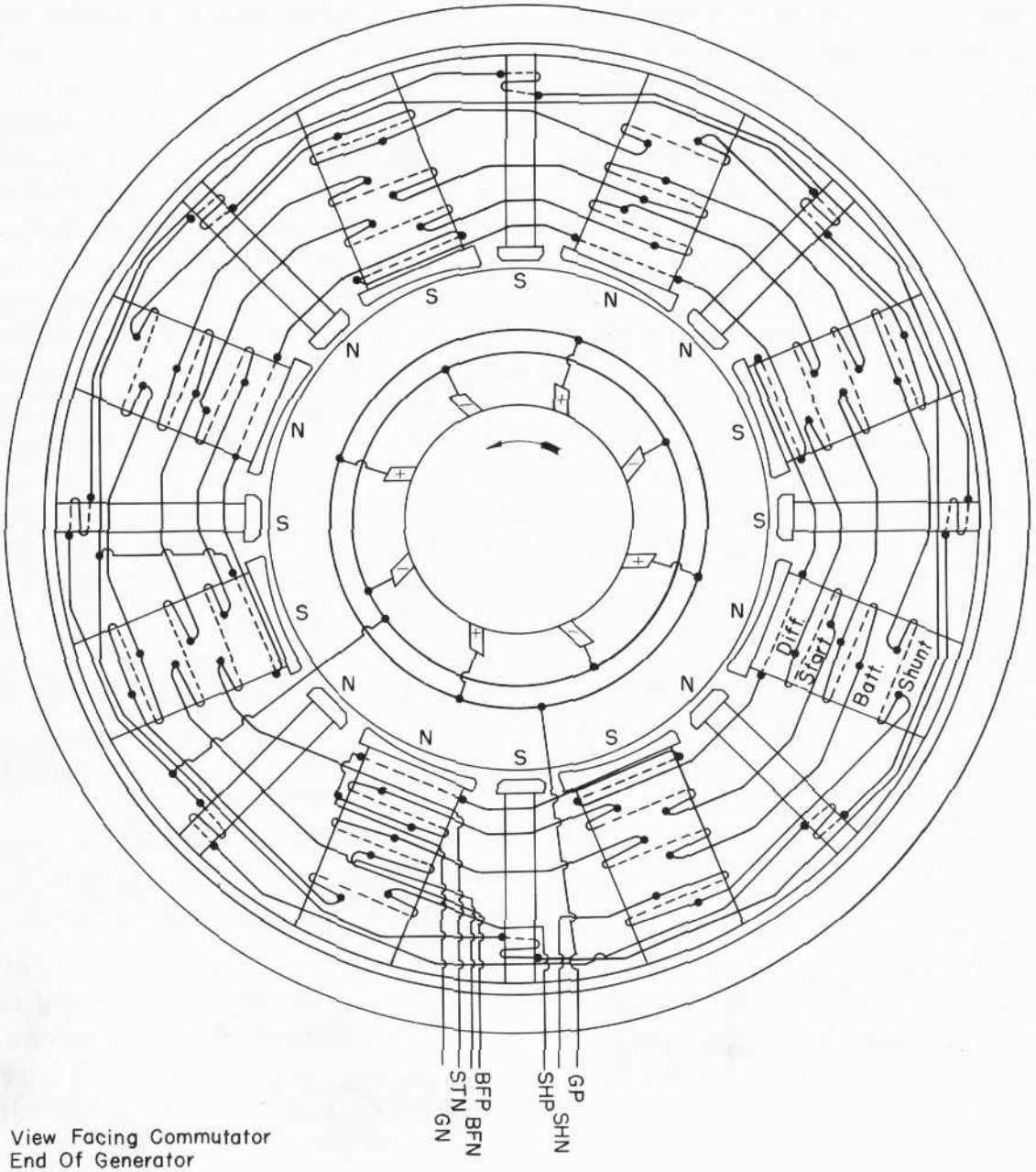
2. Make a cold resistance measurement on fields. The resistance values of the field circuit should be as shown when corrected to 75° C.



View Facing Commutator
End Of Generator

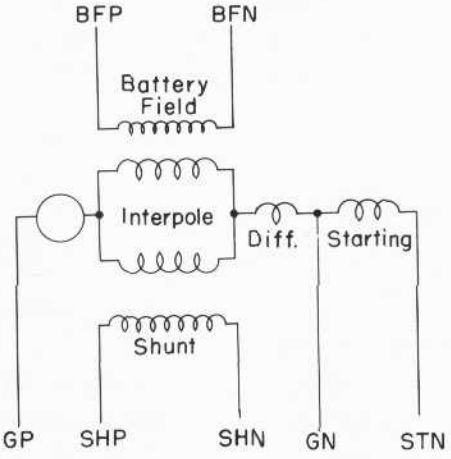


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Fig. 11 — Generator Wiring Diagram

Differential field	.000898 to .000934 ohms
Interpoles	.00398 to .00414 ohms
Starting field	.00514 to .00536 ohms
Battery field	1.188 to 1.236 ohms
Shunt field	
D15 and D15A	106.4 to 110.8 ohms
D15B and D15C	71.3 to 74.3 ohms
D25B and D25C	71.3 to 74.3 ohms

3. A polarity test, if necessary, can be made with the aid of a magnetized dip needle and by applying 15 volts direct current to the shunt or battery fields. For starting, differential and interpole fields use 80 amperes direct current. See Fig. 12 for polarity diagram.

Insulation Of Connections

Connection straps and cable lead to coils should be inspected to determine if they are electrically satisfactory and *mechanically secured.*

Insulate all shunt field soldered connections with 3 layers of Empire tape and 2 layers of friction tape half-overlapped. Apply fish paper insulation around shunt

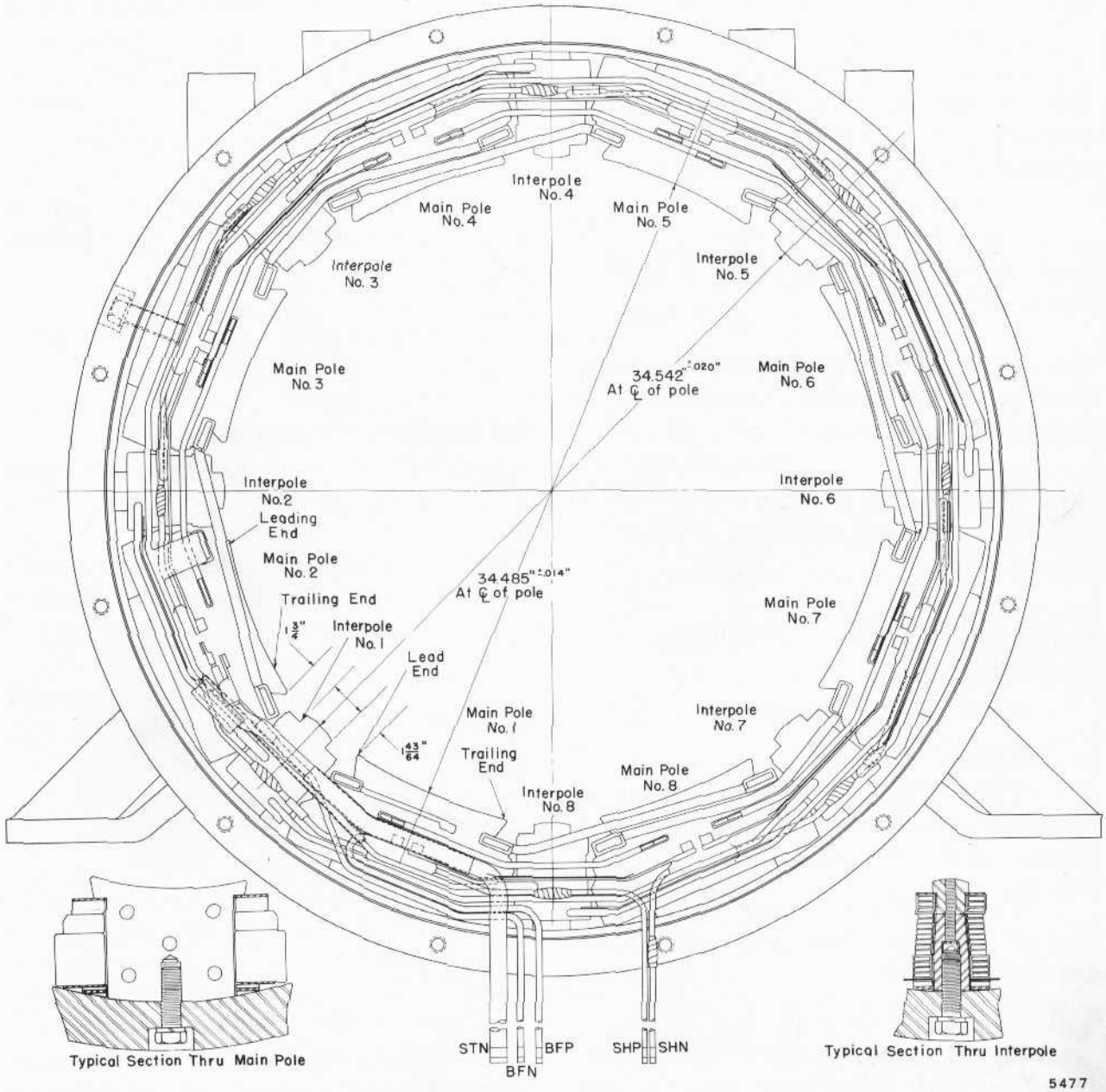

Fig. 12 — Generator Stator Assembly

cables and tie to interpole straps with torpedo twine.

Insulate interpole soldered connections next to the frame and all battery field soldered connections with 3 layers of Empire tape half-overlapped and 2 layers of white cotton webbing half-overlapped. Fasten by looping last turn of webbing under preceding turn. Paint webbing cloth with red air-drying insulating enamel. After red enamel dries, paint with 8160879 clear baking varnish and bake at oven temperature not exceeding 160° C. for five hours.

Insulate between battery field connectors and starting field connectors, starting field connectors and interpole connectors with fish paper insulation.

Tie all connectors with 1/16" torpedo twine where fish paper insulation was inserted.

External lead cables are taped with two layers of friction tape half-overlapped in the following manner:

Starting lead — Begin taping 6" from coil connector and extending at least 1" beyond clamp.

Battery leads — Tape from coil to 1" beyond clamp.

Shunt leads — Tape from splice to 1" beyond clamp.

The "BFN" and "BFP" leads extend 36" from end of cleat and have clasp connectors soldered to leads.

The "SHP" lead extends 36" from the end of cleat and has pressure applied terminal lug.

On D15 and D15B, and on D15A, D25B, D25C, D15C, the "SHN" lead extends 36" from the cleat. Lead has soldered clasp connector.

On D15 and D15A, the "STN" lead extends approximately 6" from the cleat and on D15B and D15C the "STN" lead extends 8" from cleat. Lead has pressure applied terminal lug.

Insulate the internal bolted connections with one layer, double thickness Empire cloth. Tape over the Empire cloth with three layers of Empire tape and over the Empire tape with one layer of treated glass tape.

Pole bolt holes which had the asphalt compound removed should be cleaned and repainted with black air drying varnish before refilling with compound. All pole bolts above the horizontal center line are filled with asphalt compound.

All connections and stator windings are sprayed with 8160879 clear baking varnish.

For high potential testing see Maintenance Instruction 6800.

NOTE: Ground both sides of battery field circuit when hypotting the shunt field circuit.

Ground both sides of shunt field circuit when hypotting the battery field circuit.

Make a resistance test of fields with Kelvin Bridge, see wiring diagram, Fig. 12.

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. 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 the manufacturer.

The coil insulation should be clean and free from blisters, flakes, or cracks on the insulating varnish surface. Vacuum impregnating facilities are required when the condition of the insulating varnish on the armature is such that treatment is necessary. If such facilities are not available, return the generator to the manufacturer.

If solder has been thrown out of the commutator risers, the armature should be rewound with new coils.

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 hand stone 8149435. This stone will remove the undesired film, dirt and grease like an eraser and does not affect the face of the brush. After grinding, the stone can also be used to remove slight imperfections.

Should the surface of the commutator become etched and burned to the extent that it needs resurfacing, this should be done with a standard grinding fixture.

Commutator Grinding

In the event that the commutator is burned or pitted to the extent that resurfacing 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, providing new brushes are to be 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 left side, looking into the commutator end, be removed). The grinding fixture is made up of two parts, the supporting adapter 8195928 and the grinder. Mount the grinder on the supporting adapter and install as a unit in place of the brush holder, and securely clamp in place by the brush holder blocks, as shown in Fig. 13. Square the grinder up with the commutator, using alignment bar 8210141, so that the crossfeed will run parallel with the commutator bars. The use of vacuum cleaner 8210140 and dust collector 8210142 is recommended to effectively collect copper and stone dust during grinding.

Mount stones so they are seated squarely on commutator. With radial feed,

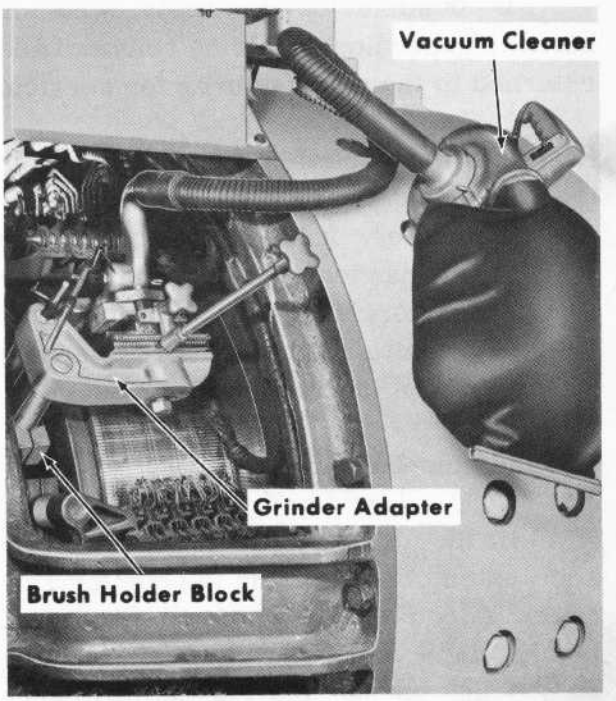

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Fig. 13 — Commutator Grinding Fixture

pull stones away from commutator and start engine (run at idle speed for grinding). Feed stones into commutator slowly until light contact is made, then run stones across commutator. To finish, run stones across commutator several times without feeding radially.

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

After grinding commutator, the generator should be cleaned thoroughly. First remove all loose copper from inside of generator. Using dry compressed air, blow the generator out thoroughly. 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 out whenever examination shows that bright mica is not visible. To clean, use a hacksaw blade that has had the tooth "set" ground off and is of the proper thickness.

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

NOTE: Emery cloth or emery paper should NEVER be used on 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 the 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 to allow 3/8" radial wear, which allows a minimum diameter of 26-1/4".

Neck Width — The minimum neck width allowable is 11/16". If the neck width is less than the allowable tolerance after several turning operations, the commutator should be replaced.

Neck Diameter — The minimum diameter for cleaning up the outside diameter neck is limited by the location of the top edge of the armature coil. No commutator neck diameter should 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". When undercutting the width of the mica, an undercutting saw 8238905 should be used.

After undercutting, burr the commutator with a hand scraper to remove sharp edges from commutator bars. After burring the commutator, 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 they 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 surface marked "X" and "A" and from "X" to "Y" with 00 grade sandpaper. Sand smooth applying a light pressure when sanding over the commutator string band. See Fig. 14.
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 hypot 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 the paint is wet.

In earlier maintenance instructions the red commutator paint recommended was "Sterling S-345" with Xylol as thinner. It is now recommended that Flintflex Red (153-0895) be used because of its faster drying property. All stock of "Sterling S-345" may be used until depleted. Thinner is not required for Flintflex, if container cover is kept tight and brush is 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)

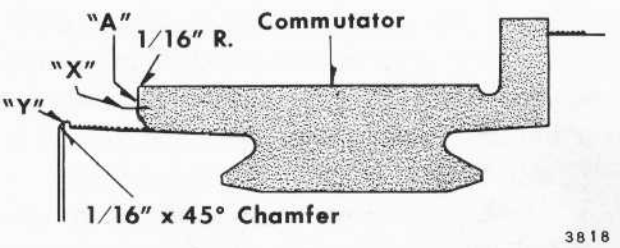

Fig. 14 — Creepage Surfaces

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 inflamable 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 megohmmeter 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 2 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 1000 volts. 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 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 lead 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 or cleaning 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 by vacuum impregnation as follows:

1. Place armature to be impregnated in a convection oven and preheat so the average core and winding temperature is between 120° C. and 130° C.

2. Remove armature from the oven and place in vacuum tank, raise 28" of vacuum for 10 minutes.

3. Using clear baking varnish 8160879 and holding Ford Cup #4 viscosity between 40 and 55 seconds at 21.1° C., using xylol 8089758 for thinning and maintaining an average varnish temperature between 20° C. and 50° C., pull varnish into tank with vacuum to proper level and continue vacuum for 2 minutes.

4. Release vacuum and apply CO_2 for one hour maintaining a pressure between 60 to 80 psi.

5. Drain varnish from the impregnating tank.

6. Raise second vacuum of 28 psi for 30 minutes.

7. Using vacuum draw varnish into tank to proper level and apply 80 lb. pressure with CO_2 for 15 minutes.
8. Drain varnish from the impregnating tank.
9. Raise a third vacuum of 28 psi for 30 minutes.
10. Release vacuum and remove armature from the tank, place armature into oven and bake for 8 hours at 130° C.
11. After baking check tightness of commutator bolts at 300 ft. lbs. with torque indicator wrench, within 15 minutes after removal of armature from oven.

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

Apply a high potential ground test to armature at 1050 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 4.7260" + .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, AC ROTOR, AND BEARING REMOVAL

Before the generator is removed from the locomotive unit, proceed as follows:

1. Place strips of fish paper 1/16" × 3" × 36" in the bottom air gap between the armature and field pole cores of the direct current generator. Fish paper does not have to be placed between the alternator rotor and its stator on generator with alternator.
2. Brushes should be removed from commutator and slip rings, and protect the commutator with a ring of fish paper.
3. Mount the generator or generator-alternator assembly on steel "I" beams at a suitable height from the floor. Use anchor shackle and base fixture for lifting complete generator assembly.
4. Remove commutator covers, air box assembly, collector ring cover, lubricating tube drain pipe assembly, and alternator collector ring cleat.
5. Remove glass tape and Empire tape from bolted connections and remove bolts from busses. Remove the upper and lower cable cleat assembly from the support piece.

6. Remove collector ring brush holders, cable connection, and remove cables from terminal posts to collector rings.

7. Remove looms from cables, unsolder terminal lugs, remove generator flange, and remove alternator cable conduit bushing.

8. Remove alternator collector ring assembly and bearing retainer from shaft.

9. Apply carbon fixture to spider bore of alternator rotor.

10. Using two wire cable loops, place one loop around the main drive coupling, rear end of generator and the other wire loop around the arbor fixture. With aid of hoist, raise end of armature off pole pieces. With aid of second hoist, raise the front end until the cable is taut.

11. Insert 3 jack bolts in the 3/4"-10N.C. class 3 thread tapped holes provided in end housing, and free end housing from generator frame.

12. Remove bolts from bearing cover and remove cover. Remove the bearing housing off the outer bearing race so that armature assembly may be "walked-out" through the alternator stator end.

13. Ease the armature and alternator rotor out of frame toward the alternator end. Care must be exercised not to injure the laminations or windings. Do not allow the armature to rub on the poles.

14. Rest armature and alternator rotor assembly on a cradle. The cradle should be high enough from the floor to clear the bus connection on the end housing.

15. To remove the remainder of bearing assembly, apply fixture as shown in Fig. 15 and remove inner and outer oil rings, bearing cap and bearing.

16. To remove the alternator rotor from generator armature, remove the generator coupling disc from the main drive coupling, and remove the main drive coupling from the alternator spider.

NOTE: Before removing disc, observe the position of the disc and coupling. Each is stamped with the armature number in exactly the same position of each piece. Keep disc and drive coupling mated with the armature.

17. Before removing main drive coupling from alternator rotor, mark the original position of main drive coupling on alternator rotor spider with a cold chisel. Remove drive coupling to armature spider bolts and insert 3 jack bolts in the 1/2"-13 N.C. class 3 threaded holes and remove coupling.

18. To remove the alternator rotor from generator armature, remove lockwire and bolts, holding assemblies together, and free the alternator conduit tube flange. Apply two wire cable loops over each end of the alternator rotor spider. Insert 3 jack bolts in the 1/2"-13 N.C. class 3 threaded holes and with aid of hoist, remove alternator rotor.

NOTE: Before removing the alternator rotor, mark the original position

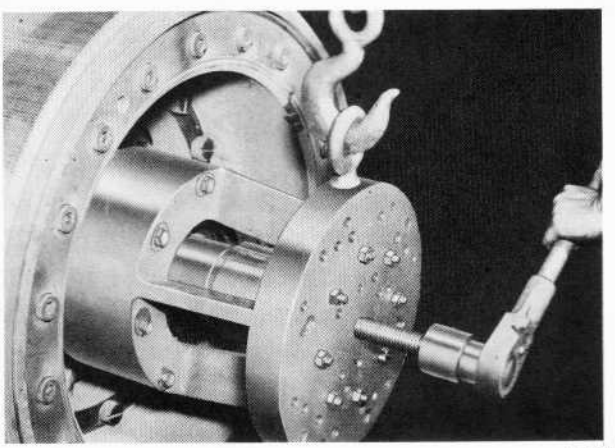

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Fig. 15 — Bearing Removal Tool

of alternator rotor to generator armature with a cold chisel.

The preceding procedure may be applied to armature removal from generators not equipped with alternators by "walking" armature through the commutator stator end.

For removal of alternator stator from main generator stator, or for removal of alternator rotor from main generator spider refer to Maintenance Instruction 3306.

ARMATURE BEARING INSPECTION

The roller bearing should be thoroughly inspected for possible evidence of impending failure. If there is 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 an inspection, a bearing must be thoroughly cleaned. A mixture of 50% carbon tetrachloride and 50% Stoddards ASTM, D484-40 or similar non-corrosive solvent is suitable for this purpose.

CAUTION: The Stoddard's solvent has a flash point of 115° F.

After washing in solvent, care should be exercised so that cloth threads, brush bristles, or other foreign matter do not enter bearing. Compressed air free from foreign matter may be used to dry bearing. When using compressed air, the rotating bearing parts should not be moved in order to prevent scoring of the bearing.

After inspection, bearings should be dipped in oil to prevent corrosion and wrapped in clean non-corrosive wrapping paper 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.

NOTE: Handle bearings with clean, dry hands to prevent staining and corrosion.

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 loaded 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 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 distinquished 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 bearings which have been run. However, should a bearing show signs of more than normal distress, and should there be any question as to their detrimental effect on life of the bearing, the bearing should be replaced.

Scratches

Scratches due to mishandling, etc., in general are not serious, providing they are small. Scratches may be recognized because they will be bright in the bottom after being cleaned. Scratches on the surface, parallel to the length of the bearing are more serious than those at an angle. If there is any doubt that a scratch is a crack, it should be treated as a crack due to fatigue failure.

Heat

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

Cages

Bearing cages showing 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.

GENERATOR ASSEMBLY (WITH OR WITHOUT ALTERNATORS)

Generator assembly is divided into two operations, armature bearing assembly and final generator assembly. The following operations should be performed either before or during bearing assembly.

On Generators With Alternators

1. Bolt the alternator stator assembly to the generator assembly as shown in Fig. 16, using plain washers and lockwashers with the bolts. Tighten the bolts alternately to draw up the stator evenly.
2. If the generator coupling disc was removed from the main drive coupling, bolt disc to main drive with self-locking nuts which are alternately tightened to draw up the coupling evenly. Coupling bolt nuts must be tightened to a torque value of 1200 foot-pounds.

NOTE: The coupling bolt holes on early main drive coupling and generator coupling discs were reamed as an assembly at the factory and were stamped with the armature number in exactly the same position on each part. This was done to keep the drive coupling and disc with the armature assembly. It is no longer necessary to keep them matched, as bolt holes are not a reamed fit. Standard bolts have a loose fit in bolt holes and must be torqued to 1200 foot-pounds.

3. If main drive coupling was removed, bolt it to alternator rotor spider before applying coupling disc to main drive. Secure bolts with lockwire. Before bolting main drive coupling to rotor spider, align chisel mark on main drive with chisel mark on alternator rotor (which were made during disassembly of coupling).
4. The generator armature and alternator rotor are dynamically balanced.

Armature Bearing Assembly

Before shrinking armature bearing to shaft, it is very important that the bearing be tried in its housing 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".

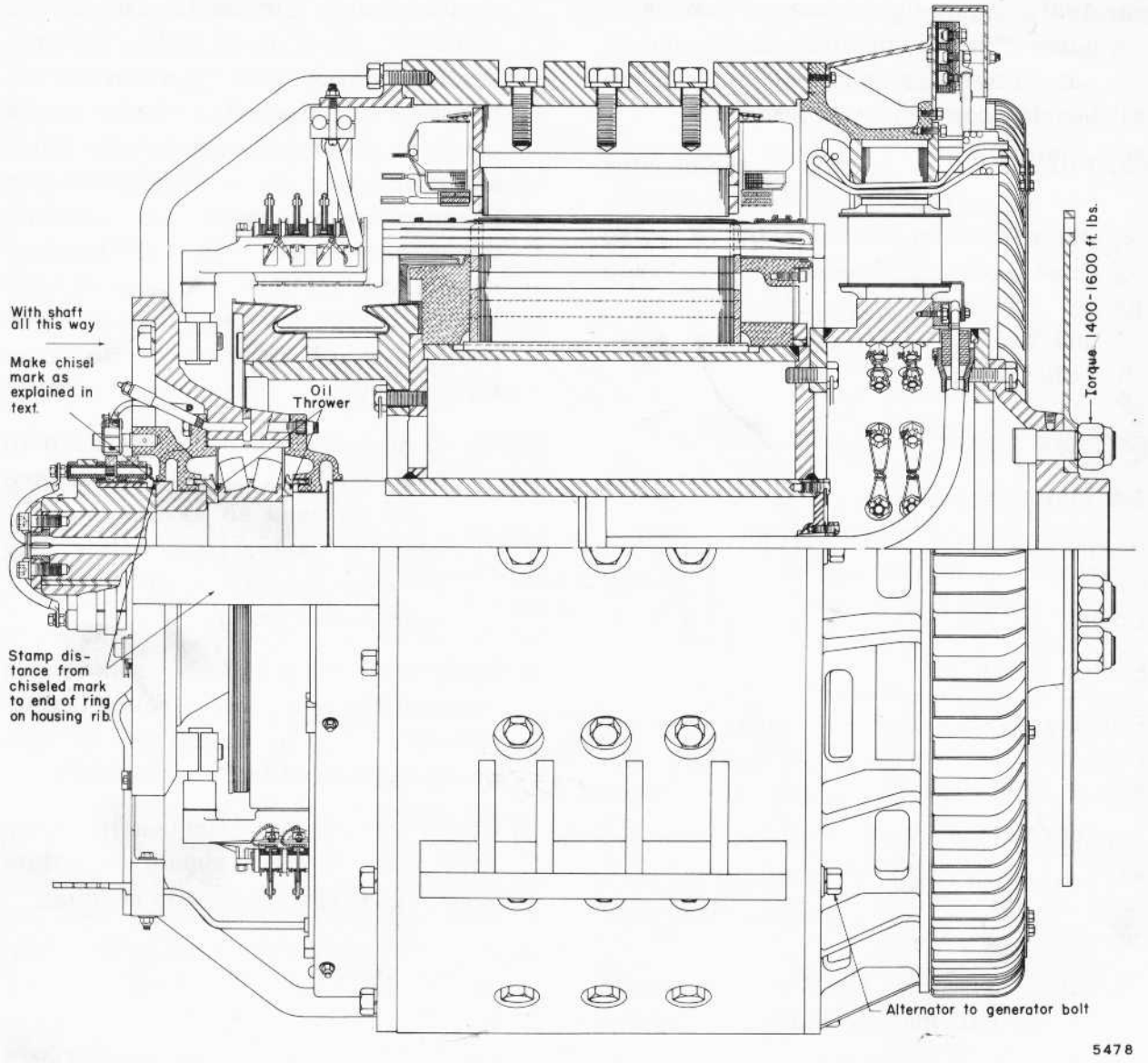

Fig. 16 — Cross-Section Of Generator-Alternator

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 minimum allowable tolerance the recommended clearance would not prevail.

Bearing Dimension and Tolerance (New Bearing)

Outer Diameter	10.2362" + .0000" - .0014"
Bearing bore	4.7244" + .0000" - .0008"
Width	3.386" + .000" - .005"
End Play Clearance	3/16"

Internal Clearance (before assembly)

Serial number with C3	.0025" to .0045"
Serial number with C3R	.0035" to .006"

Internal Clearance (after assembly)

Serial number with C3	.0015"
Serial number with C3R	.0025"

Armature Bearing Assembly to Shaft

1. Remove old grease from bearing cap and cover. Clean bearing cap cover. Repaint with crankcase paint and allow to dry.

2. Apply an unweighed amount of grease, same type as specified for bearing in the following Grease Chart, 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 shown in the following Grease Chart. Grease outline should be 180° to 200° for additive bearings, and 240° to 270° for sealed bearings. Refer to Fig. 17.

GREASE CHART *Diagrama de la grasa.*

Additive bearing*

Bearing	12 oz. ± 1/4 oz. 340,209 gs
Cap	13 oz. ± 1/4 oz. 368,55 gs
Cover	13 oz. ± 1/4 oz. " " "

Sealed bearing**

Bearing	13 oz. ± 1/4 oz. " "
Cap	17 oz. ± 1/4 oz. 481,95 gs
Cover	20 oz. ± 1/4 oz. 5953,58

*Lubrico M-6	8004748
**Cyprina RA Grade 3	8249819 (35 lbs.)
	8249820 (120 lbs.)

4. Clean armature shaft, remove burrs or any gall marks. Place bearing cap on shaft.

5. Heat the inner oil thrower in an oil bath or an 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. If an oil bath is used for heating, remove the oil from the oil thrower with clean bound edge cloths prior to shrinking on the shaft. When using an induction heater, pyrometer readings (with current off) should be taken periodically. After heating, shrink the oil thrower to shaft, see Fig. 16 or 18 for proper position on shaft. Let oil thrower cool to room temperature.

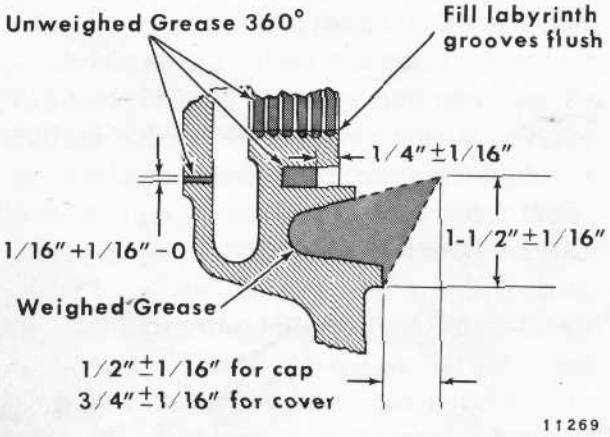

Fig. 17 — Application Of Grease To Bearing Cap

NOTE: If an induction heater is used to heat bearing assembly parts, care must be used so as not to overheat the parts. Overheating may result in warping or metallurgical upsetting of parts.

6. Pack the bearing rollers and the space between the two rows of rollers completely with the quantity and type grease specified in the Grease Chart.

7. Check the runout of the bearing inner race face. Runout should be within .002" of the total indicator reading.

8. Apply two studs 8159226, 180° apart, to the 1/2"-20 N.F. class 3 thread spline nut which is pressed in place to the bearing cap, see Fig. 19. 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.

9. Heat outer oil thrower in an oil bath or in an electric oven for half an hour at 248° F. or 120° C. If induction heater is used, heat up to 248° F. or 120° C. Then proceed as per Step 5.

10. On generators with alternator assembly only, after completing Step 9, assemble generator armature with alternator rotor assembly into generator and alternator stator assembly.

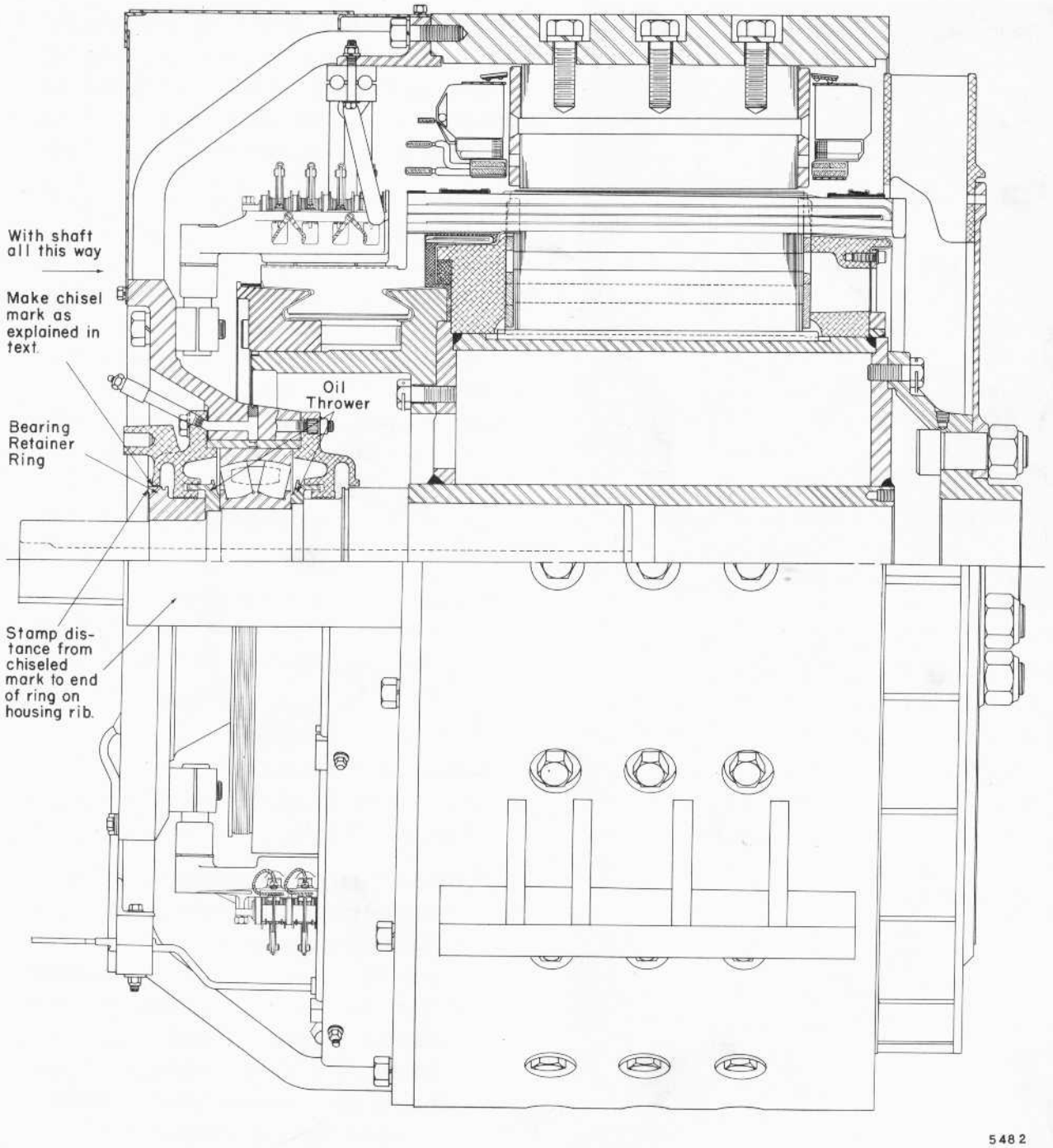

Fig. 18 — Cross-Section Of Generator

When installing the rotor assemblies, the commutator end of the armature is first inserted through the alternator stator assembly end. Insert lifting arbor fixture over armature shaft. With two wire cable slings, place one sling around the arbor and the other around the main drive coupling which is bolted to the rotor spider. With the aid of two hoists, lift and guide the rotor assemblies into the stator assemblies being careful not to injure the lamination or windings. Remove cables and arbor after armature and rotor is assembled in the frame.

11. Clean bearing housing bore with APCO and apply Molykote M88, 8168822 with a brush or spray; allow to dry. Place aligning tool 8060275 as shown in Fig. 19, on the shaft to hold the outer race stationary and to assist in

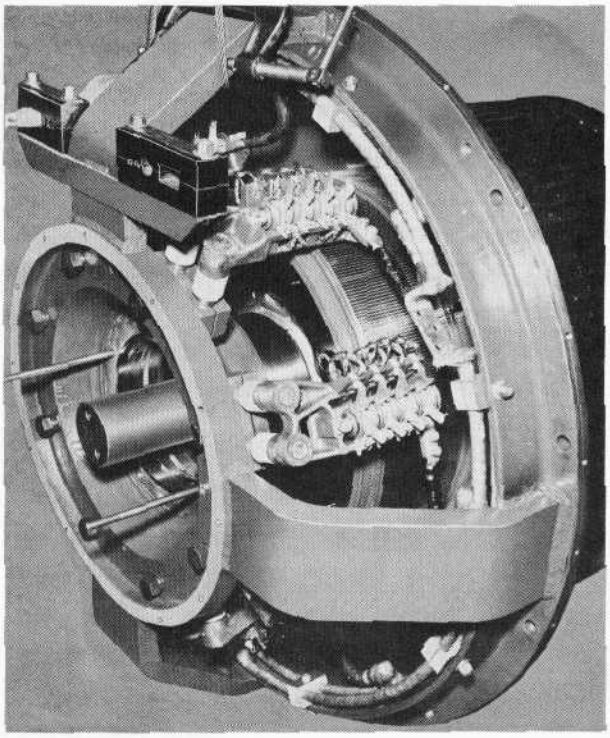

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Fig. 19 — Applying End Housing Over Fixture And Bearing

placing the end housing over the 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 bearing cap drain hole.

The generator end housing assembly has a sleeve 8120569 pressed into the bore. The sleeve is aligned in the housing bore, before pressing, so that one of the 3/8" holes in the sleeve aligns with the pipe plug on the outside diameter of the housing bore to match the grease hole in the housing bore to the hole in the bearing sleeve.

Production Tolerance Chart

Bearing housing bore diameter	11.0244" + .0010" - .0000"
Sleeve outside diameter	11.0274" + .0000" - .0010"
Sleeve inside diameter (after assembly)	10.2397" to 10.2367"
Sleeve out-of-round (maximum allowance)	.002"

12. Fill the outer bearing cover pocket with the recommended grease around the lower 180° to the level indicated in Fig. 17. Fill the lubricating tube with grease and apply to the cover. Apply a new gasket to the bearing housing. Bolt the bearing cover in place on the bearing housing, aligning the cover drain hole with the housing drain hole. Remove the two studs used previously for aligning assembly parts.

NOTE: Bearing covers used on generators without alternators do not have slip ring brush holder studs in the covers. See Fig. 18.

13. Heat bearing retainer ring on induction heater to 260° F., or 127° C., and shrink to shaft. See Fig. 16 or 18 for position on shaft.

NOTE: Check armature end play, approximately 3/16", by moving end housing over bearing. Armature should be positioned all the way back into stator, at assembly, for ease in later alignment. Protect commutator with fish paper covering to prevent brush holders from marking commutator bars.

Make a measurement check from chisel marks to end face of bearing retainer and compare with the dimension as found on the right horizontal rib of end bell housing. If measurement obtained disagrees with stamped dimension, stamp rib upper section with new dimension. Stamp "X" marks over the old number.

14. Generators With Alternators

On generators with alternators, after completing Step 13, and with rotor

assemblies in generator frame as noted in Step 10, apply wire cable sling to the main drive coupling at alternator rotor end and to the armature shaft. Lift armature and rotor assembly to clear pole pieces and bring end housing to generator frame. Bolt end housing to frame assembly being careful not to start dowel pin into generator frame first.

Generators Without Alternators

On generators without alternators, after completing Step 13, apply arbor to main drive coupling which is bolted to armature spider. Be sure generator coupling disc is removed from main drive coupling as outside diameter of disc is larger than inside diameter of field assembly in stator. Apply wire cable slings as shown in Fig. 20, and assemble armature into frame. Bolt end housing to frame assembly being careful to start dowel pin into generator frame first.

15. Place fish paper strips 1/16" × 3" × 36" in air gap between armature and bottom field poles to prevent armature from rolling on pole cores during transportation. On generators with alternators do not apply fish paper strips in air gap between alternator rotor and stator. Remove wire cable slings from arbor and generator shaft.

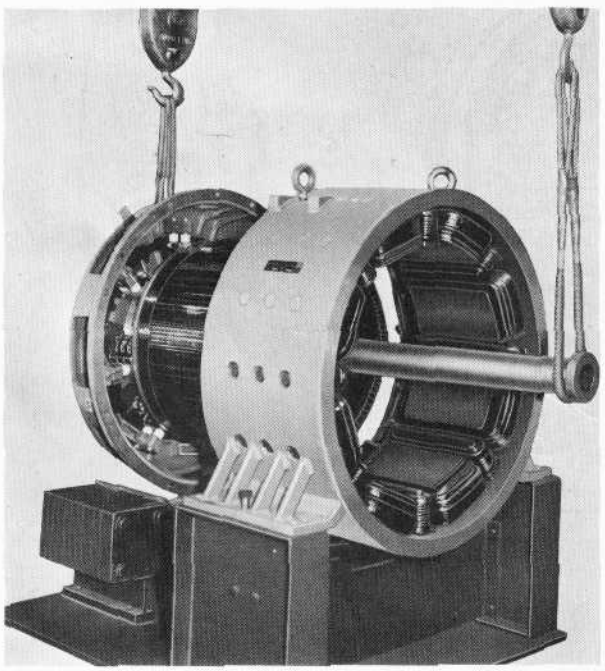

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Fig. 20 — Removing Or Installing Armature Into Frame

Final Assembly Of Generators Or Generator-Alternators

The following steps pertain only to generators with alternators:

1. 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. 16.
2. Assemble conduit bushing on cables and insert into end of shaft. Bolt shaft flange to end of shaft.
3. If new cables are used cut and skin to allow enough slack in cables to clear bolt heads. Solder terminal lugs to cables.
4. 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.
5. Install 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.
6. Measure spring tension with the spring 1/8" above top of brush holder, should be 1-1/2 to 1-3/4 pounds.

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.

7. Install brushes in brush holders.

8. Connect cable assembly to brush holders as shown in Fig. 21. Apply clips, brackets and insulators as shown in Fig. 21.

The following steps apply to generators with or without alternators:

9. Assemble strap connection assembly with proper bolts, plain washers, lock washers, stop nuts, pad and cable cleats, see Fig. 21. Insulate external connections as outlined under stator assembly.

NOTE: Bolted connection may heat if the contact surfaces are not clean and flat and bolted with sufficient pressure.

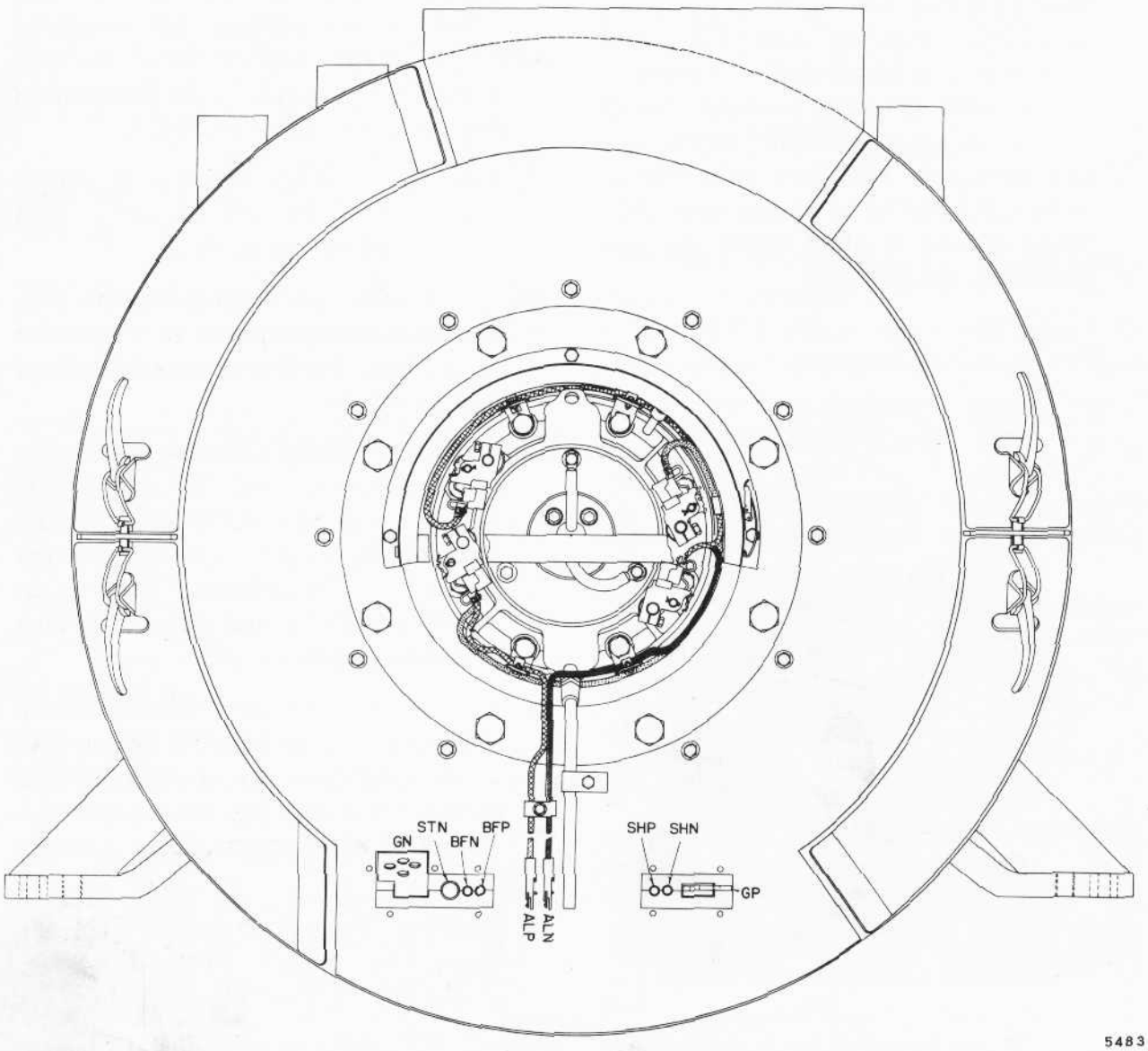

Fig. 21 — Generator Cable Connections

10. Install split brushes in brush holder carbon boxes and bolt shunts from brush to brush holder.

NOTE: Refer to information on the brush holders and the brushes in regards to spring tension and clearance between the brush holder and commutator. Twisting of carbon brush shunts is not necessary.

11. Apply air box assembly and commutator covers to generators with alternators.

    Apply commutator covers to generators without alternators.

12. Apply connector tube and drain pipe assembly to bearing cover.

With the generator assembly completed and ready for testing, it should be given an insulation resistance test. The minimum passable allowance is 1 megohm. If less than 1 megohm, cause for low reading should be corrected before proceeding with bearing test.

BEARING TEST

After overhauling the generator, a bearing run-in test should be made at 800 RPM, with a minimum time of two hours. At the end of a two hour run, the bearing temperature should not exceed 30° C. rise. Any bearing exceeding this temperature must level off at 35° C. rise, or below.

NOTE: Add eight ounces of approved grease to the generator bearing at the beginning of bearing run, with the armature rotating when grease is added.

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 100 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 of the insulation. The condition may be aggravated by sudden temperature changes. Thus, if the equipment has been allowed to stand outside during cold weather long enough 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 and traction motors is 600 volts. Therefore, the minimum test voltage should be:

Motor and generator	900 volts
High voltage wiring and high voltage equipment	1000 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 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. 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 EMD 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 main generator only to prevent damage during shipment. Each generator shipped from Electro-Motive Division has a skid and supporting jack. Generators shipped back to Electro-Motive should be returned using this skid and jack.

The compressor coupling guard 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 had on request as an aid in shipping the generator.

INSTALLATION OF MAIN GENERATOR OR GENERATOR-ALTERNATOR IN LOCOMOTIVE UNIT

The installation of main generator with or without alternator is similar to the 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 fit on generator coupling disc and the fit in the engine timing ring, both must be smooth and clean. Add a little oil or white lead to the fitting surfaces. Check bolt holes in couplings, should be clean and smooth.

Turn the engine coupling disc by barring or jacking, so that the large hole (7/8" hole, the remaining holes in disc are 3/4") will be in line with the large hole in the generator disc.

Apply a 2-3/16" socket wrench to engine and generator coupling nuts to make sure they are tight. All 1-1/2"-12 coupling bolt nuts must be tightened to a torque value of 1400 to 1600 foot-pounds.

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

Lift generator and guide slowly and carefully into engine room.

Set generator as close as permissible to engine coupling, align 7/8" bolt holes and push generator toward engine. Install the 7/8" bolt first to make sure both coupling discs are connected properly. Install a 3/4" bolt 180° from 7/8" bolt. Tighten nuts of both bolts evenly making sure generator disc is not cocked and enters freely into timing ring.

Remove all fish paper or fibre strips between the armature and the field coils before barring or jacking engine over. There should be no fish paper under the alternator field.

Install the remainder of the 3/4" bolts to coupling and tighten.

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

ALIGNING GENERATOR WITH ENGINE

The alignment of the generator with the 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 engine disc coupling.

3. Radial

   Balancing and setting the air gap between the generator armature and the field poles.

ALIGNING GENERATOR BEARING

After the generator is coupled to the engine, careful location of the generator frame is important in order to locate the single bearing at the commutator end and avoid a thrust load in either direction. The generator has a total end play of 3/16". A thrust clearance or end play of 1/16" + .00" - 1/64" between the bearing outer race and the inside bearing cap must be maintained.

1. Remove one oil pan hand-hole cover and eliminate all crankshaft thrust by prying against a crankshaft web and crankcase. Move all crankshaft end play toward generator end of the engine.

2. Locate a measurement number stamped in 1/2" numbers on the end bell beneath one of the end bell commutator sheet metal covers. To this reference measurement "X" is added the 1/16" + .000" - 1/64" end clearance. (Measurement "X" is approximately 1/8".)

3. Move the generator frame away from or toward the engine to obtain this total measurement which will be 3/16" + (1/16" + .000" - 1/64") from the machined face of the bearing cover to the end face of the shaft retainer. This will also equal 1/16" + .000" -1/64" between the chisel marks and the machined face of the bearing cover.

ALIGNMENT PROCEDURE

The proper operation of the power plant requires that the generator armature shaft and generator frame be in line with the 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.

1. Using two dial indicators mounted on supports attached to a rod screwed into a tapped hole in the coupling adapter, a measurement of the coupling misalignment and generator air gap variation can be determined. The plunger of one indicator contacts the back of the generator coupling disc opposite the serration at the bolt circle. The plunger of the second indicator rides

on the outside machined diameter of the alternator housing as shown in Fig. 22 to indicate air gap. Both indicators revolve together.

2. Rotate the flywheel so that the indicator rod is in a vertical position. Depress the indicator plungers to make the pointer complete one turn, then secure it and adjust the knurled bezels to locate the pointers at zero. Depress the indicator buttons to check pointer action.

3. Turn the armature 180° in a clockwise direction (while facing the commutator) using the engine turning jack.

4. Return the indicators to the original position. If the indicators are operating correctly, the pointer of each indicator will return to zero.

5. Starting again at the top vertical position, the alignment and air gap are checked and adjustments are made to bring them within the alignment tolerances. Record the indicator readings at the 90° and 180° positions. Then rotate the armature 270° counterclockwise (facing the commutator) recording the reading for each position.

6. The generator alignment is considered satisfactory when the indicator readings are to or within the indicator tolerances given in Fig. 23. Slight shim adjustments may be required to accomplish accurate alignment. Full length shims are recommended whenever possible, although spot shims may be used to conform to limits given. Since any movement of the generator frame affects both air gap

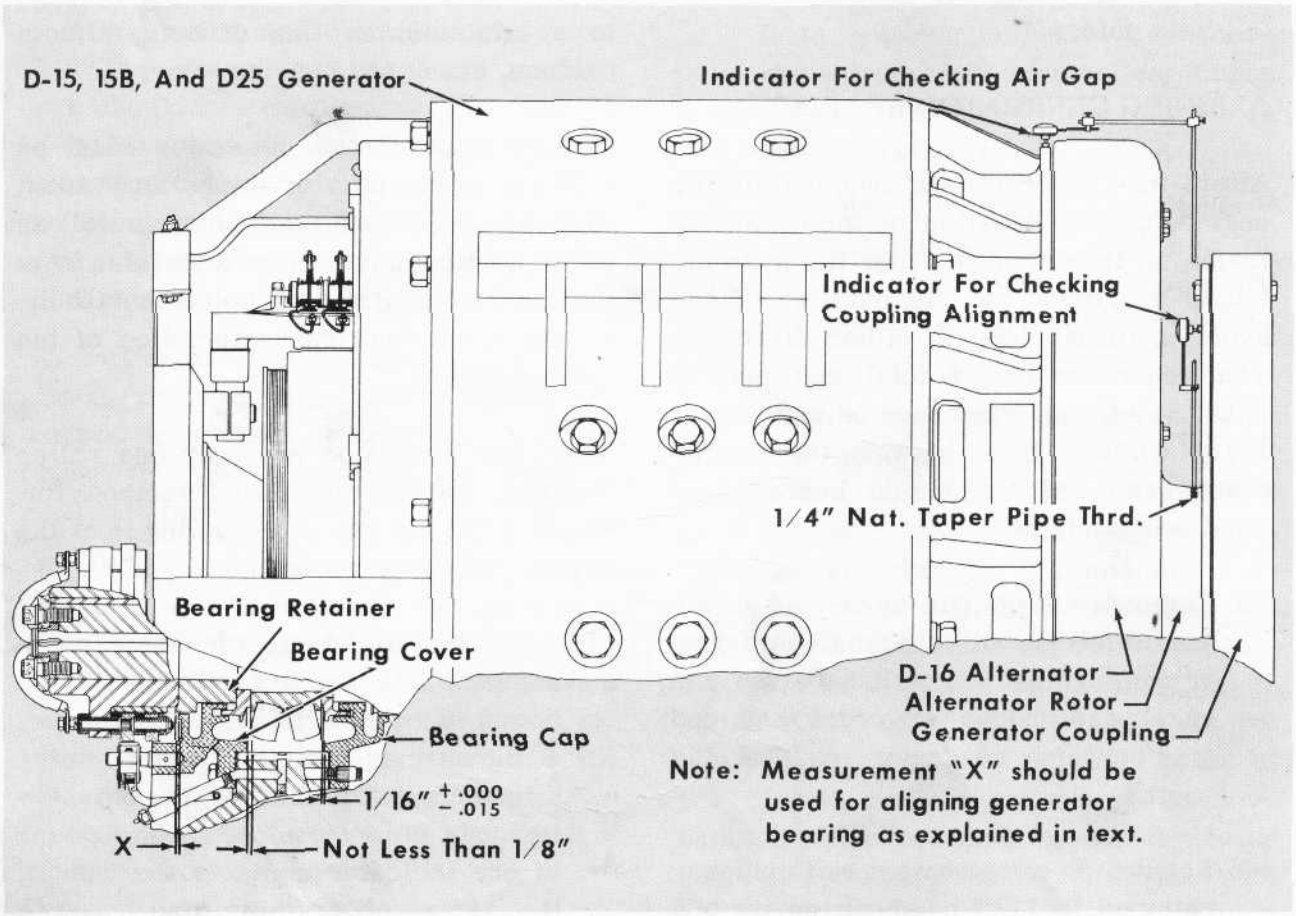

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Fig. 22 — Generator Alignment Information D15, D15B, and D25 Generators

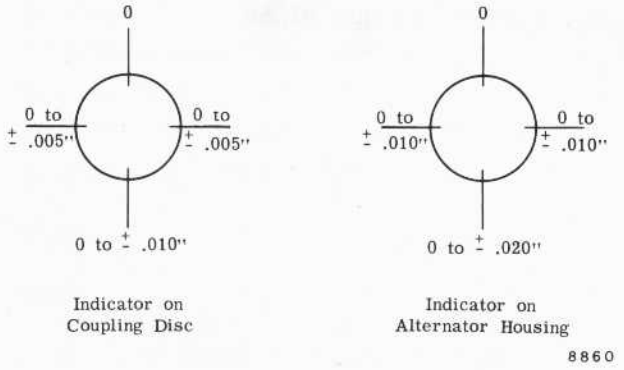

Fig. 23 — Dial Indicator Alignment Tolerances, Model D15 and D15B Generators

and the coupling, readings must be taken as each step of correction occurs.

7. Check the bearing thrust dimension after final coupling alignment.

8. After installation of a new generator and upon completion of line-up with the engine, operate 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.

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

For generator to compressor coupling alignment procedure and information, refer to applicable M.I. 1753.

MAINTENANCE DATA

Weights

Generator (complete assembly)	
Model D15-16, D15B-D16, and D25-D16 generator-alternators	11,850 lbs.
Model D15A, D15C, and D25C generators	10,400 lbs.
DC armature and coupling	4,100 lbs.
AC rotor assembly	750 lbs.
AC stator assembly	680 lbs.
Generator end housing assembly	845 lbs.
Generator stator assembly	5,350 lbs.

Nominal Air Gap (under)

Main poles	.250"
Commutator poles	.288"
AC rotor and stator	.156"

Brushes

Number of brushes per arm	4 sets (split)
Size of brush	5/8" × 1-5/16" × 2-9/16" 5/8" made up of two brushes 5/16" thick

MAINTENANCE DATA (CONT'D)

Brushes (Cont'd)

Wear limit	1-9/16" on long side
Grade	DE 2
Type	Split
Spring tension	4 to 4-1/2 lbs. (low limit 3-1/2 lbs.)

Brush holder

Total number of brush arms	8
Clearance between brush holder and commutator	1/8" + 1/16"-0"
Clearance between brush holder and brush	.003" min. .008" max.

D16 Alternator

Brush tension	1-1/2 to 1-3/4 lbs. (low limit 1-1/4 lbs.)
Number of brushes	4
Number of brush holders	4
Size of brush	3/8" × 3/4" × 1-1/2"
Brush wear limit	5/8" on long side
Grade	PL-AY solid

Commutator

New diameter	27" ± 1/16"
Minimum diameter	26-1/4"
Neck width (new)	7/8" ± 1/32"
Neck width (minimum	3/4"
Mica groove depth	3/64" to 5/64"
Mica groove width	.031"

Resistances at 75° C.

Armature	.00676 to .00650 ohms
Armature (1-11)	.00341 to .00355 ohms

Shunt field

Models D15 and D15A	106.4 to 110.8 ohms
Models D15B and D15C Models D25 and D25C	71.3 to 74.3 ohms

MAINTENANCE DATA (CONT'D)

Resistances at 75° C. (Cont'd)

Battery field	1.188 to 1.236 ohms
Starting field	.00514 to .00536 ohms
Interpole (commutating field)	.00398 to .00414 ohms
Differential field	.000898 to .000934 ohms
Alternator rotor (slip ring to slip ring)	3.03 to 3.27 ohms
Alternator stator (phase to phase)	.02054 to .01916 ohms
(Maximum allowable variation between any 2 phases)	.00015 ohms

Roller Bearing

Outer diameter	10.2362" + .0000" - .0014"
Bearing bore	4.7224" + .0000" - .0008"
Width	3.386" + .000" - .005"

Internal clearance (before assembly)

Serial number with C3	.0025" to .0045"
Serial number with C3R	.0035" to .006"

Internal clearance (after assembly)

Serial number with C3	.0015" min.
Serial number with C3R	.0025" min.

End play clearance (after assembly in generator housing) . . . . . 3/16"

Lubricant capacity

	Additive	Sealed
Bearing	12 ounces	13 ounces
Cover	13 ounces	20 ounces
Cap	13 ounces	17 ounces

Bearing housing bore diameter	11.0224" + .0010" - .0000"

Bearing housing sleeve

Outside diameter	11.0274" + .0000" - .0010"

MAINTENANCE DATA (CONT'D)

Roller Bearing (Cont'd)

Inside diameter	10.2397" to 10.2367"
Width of sleeve	4.323" + .005" - .005"
Out-of-round (maximum allowance)	.002"

EQUIPMENT LIST

COMPOUND .. Asphalt insulating	8004348
SOLDER .. Hi-Temp	8004399
SOLDER .. Tin base	8004402
TWINE .. Torpedo	8004412
SOLDER .. Sil-Fos	8004440
GRINDER .. Commutator	8052924
PAINT .. Orange enamel	8070856
WEBBING .. White cotton	8075536
PAPER .. Fish (.025" × 40" × 48")	8075555
TAPE .. Empire	8077241
STRIP .. Brazing	8084889
SAW .. Undercutting (.030)	8085255
SOLDER .. Pure tin	8107868
ROD .. Alignment	8122000
STONE .. Commutator cleaning	8149435
VARNISH .. Clear baking	8160879
ADAPTER .. Grinder	8195928
STONE .. Brush seating	8204957
CLEANER .. Vacuum	8210140
BAR .. Grinder alignment	8210141
COLLECTOR .. Dust	8210142
FILE .. Slot	8217141

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