MAINTENANCE INSTRUCTION

MAIN GENERATOR
TYPE D-12

APPLICATION: F3, F7, BL2, GP7, SD7, MRS

GENERAL DESCRIPTION

The Type D-12 main generator, Figs. 1 & 2, is directly connected to the Diesel engine crankshaft through the alternator rotor spider and a flexible coupling.

The generator produces nominal 600 volts direct current for supplying power to the traction motors. A self-aligning double spherical roller bearing in the commutator end housing carries the weight of the commutator end of the generator armature. The other end of the armature is supported by the engine crankshaft rear main bearing.

The generator is force ventilated by an impeller mounted on the end of the auxiliary generator shaft.

THIS REVISION SUPERSEDES ALL PREVIOUS EDITIONS. * THOSE PARAGRAPHS MARKED WITH AN ASTERISK (*) HAVE BEEN CHANGED FROM THE PREVIOUS PUBLICATION.

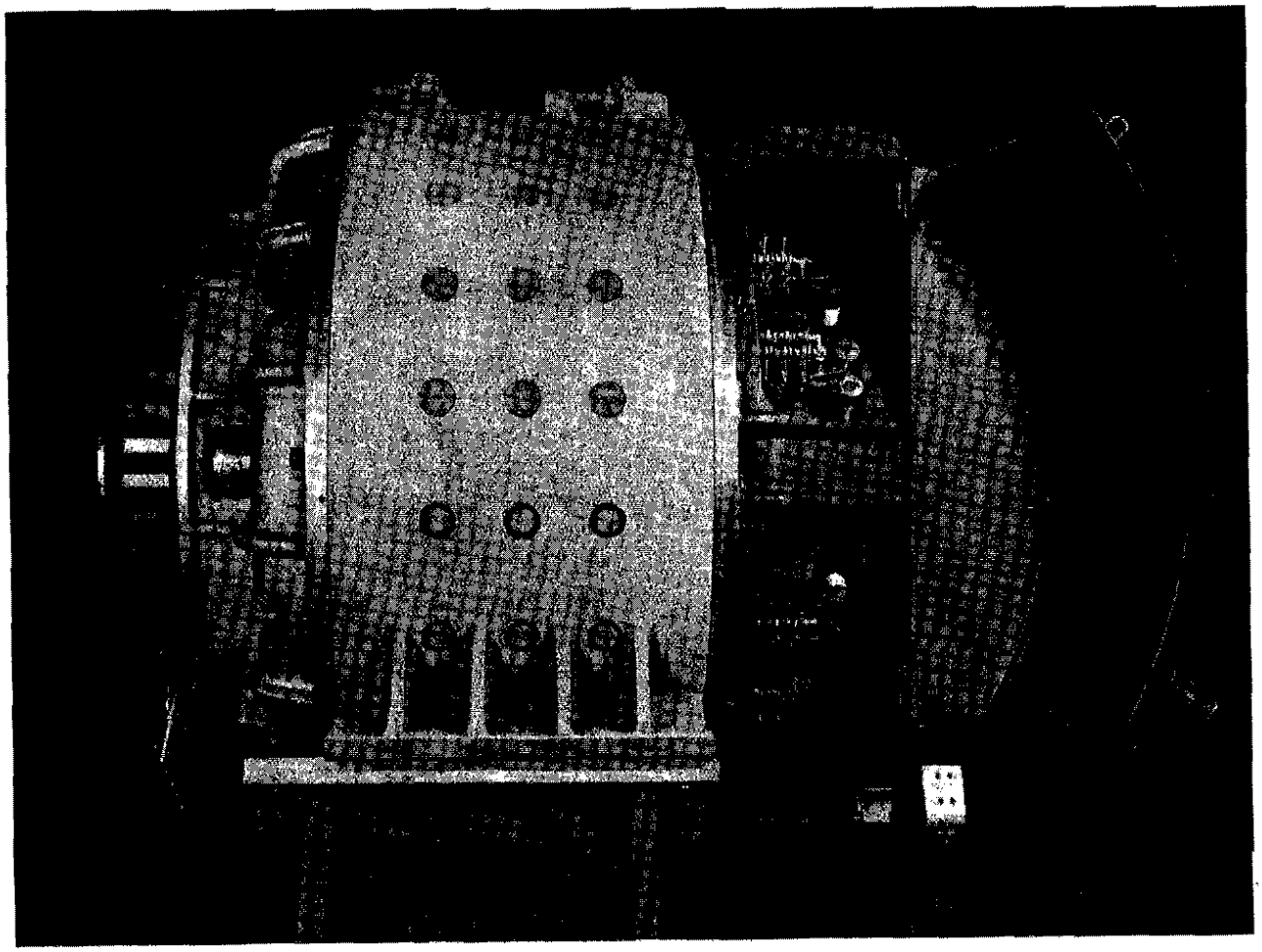

Fig. 1 - Generator Alternator Assembly

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, 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.

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.

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.

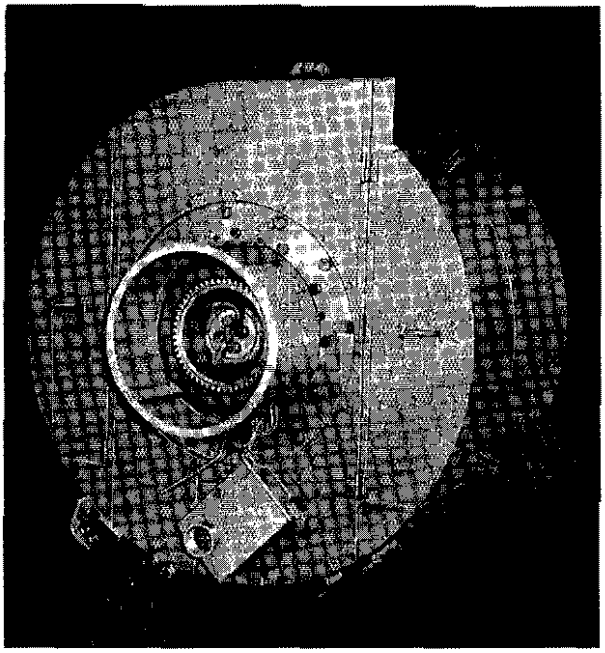

Fig. 2 - Application Of C. E. Cover

Armature -- 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 therefore 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, with periodic overhaul by thoroughly cleaning and vacuum impregnating. 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 manu-

facturer. However, Electro-Motive Division recommends that generators be overhauled with approved materials and by proper processing as often as outlined in Scheduled Maintenance Program. If proper equipment for maintenance and overhaul is not available, the generator should be returned to Electro-Motive Division 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 Scheduled Maintenance Program.

The generator must not be sprayed or cleaned with liquid of any kind. Any attempt to clean the coils and windings with a liquid cleaner will destroy the protective varnish, causing it to peel or crack. 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. In severe cases, it may be necessary to dampen a cloth in a solvent type cleaner to remove oxidized grease or 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.

Inspection

The generator should be inspected often enough to prevent failures in service. This should include the examinations of items, details of which appear under their respective headings in this Maintenance Instruction.

The general condition of the equipment may be determined by observing the commutator of the generator. The armature may be assumed to be the heart of the generator assembly through which flows the load current for distribution to the traction motors.

Lubrication

* The main generator bearing is a double spherical self-aligning roller bearing lubricated by means of a grease fitting which is secured at the front of the bearing cover. Access to the lubricating pipe is made by removing the cover over the alternator collector rings. Lubriko M-6 or Regal Starfak #2 is approved for regular lubrication. One ounce of grease should be added at periods as specified in the Scheduled Maintenance Program.

The grease fitting should be examined regularly to see that it is not damaged thus allowing dirt to enter the bearing. Before greasing, the fitting should be wiped clean so as not to force dirt into the bearing with the grease.

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.

Brush Holders And Brushes

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

Brushes should move freely in the holders, and not be stuck with dirt or other foreign substances. Release the springs from anchor pin, and raise and

lower the brushes in the carbonways so as to release 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.

Replace brushes that have been chipped or worn excessively with brushes recommended by the locomotive manufacturer. Refer to "Maintenance Data." This recommendation should be followed when only a partial replacement is made, for two different kinds of brushes in the same generator may be detrimental to its successful operation. When new brushes are installed, they should be fitted to the commutator by sandpapering. Use a 00 grade of sandpaper when sanding-in brushes; also sand brushes preferably in the direction of rotation, Fig. 3.

When installing brushes with riveted shunts, the brush shunts should be braided in order to induce stiffness in the shunts.

When installing brushes with "Q" (tamped) shunts, the shunts of the brushes next to the riser should be twisted one complete turn or braided to prevent their striking the riser. The other brushes should be left untwisted and unbraided.

CAUTION: Care must be excercised in braiding the shunts so as not to induce too great a degree of stiffness and thus hinder brush movement in the holder.

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

Fig. 3 - Sanding-In Brushes

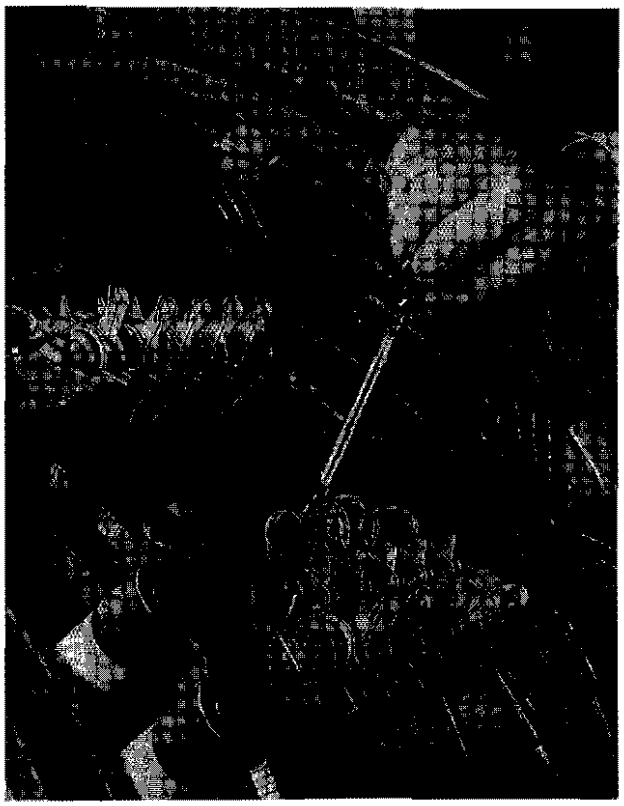

Fig. 4 - Measuring Brush Spring Tension

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 brushes be adjusted to the same pressure, as unequal brush pressure will cause 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. 4 for method of measuring 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. Fig. 5 shows a complete brush holder assembly.

The spring tension on the brush

holder is regulated in the following manner:

1. Release the springs from the anchor pin and remove brushes from brush holder to be adjusted.

2. Remove cap-screw holding clip and remove clip.

3. Move anchor assembly to the desired slot (usually second or third slot). Install clip and secure with cap-screw.

4. Insert springs to anchor pin.

5. When checking spring tension it is important to relieve the friction, if any, between spring turns and bushing. To relieve friction shake anchor assembly sideways.

Keep porcelain insulators on the brush holder assemblies clean. Do not let oil or dirt accumulate on the brush holders. Wipe the brush holders with a clean, dry cloth.

Replace when broken or cracked, by removing and replacing the defective brush holders.

The reason for removing the complete brush holder assembly and replacing with a spare one is this, when the porcelain insulator is replaced it must be cemented and baked, which takes time.

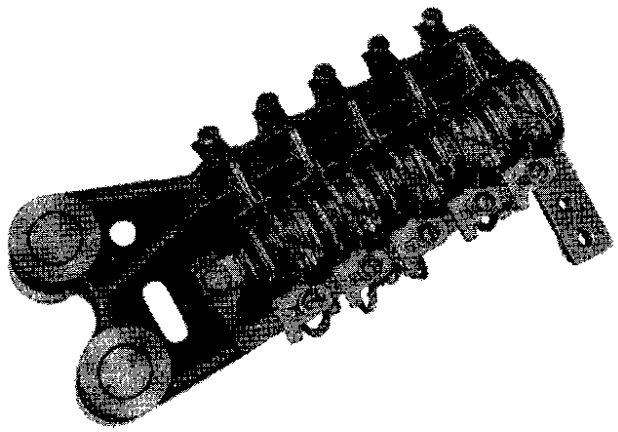

Fig. 5 - Brush Holder Assembly

When replacing porcelain insulator, the porcelain insulator should have a snug fit over the brush holder stud insulator. To accomplish this, cut a piece of Empire tape and adjust to give porcelain a snug fit over tape. Then remove the insulator and apply baking varnish on tape and inside of porcelain.

Fill around top of porcelain with brush holder cement. Make cement from the following instructions:

*Materials Required

41% Clear baking varnish (by weight).
59% Loomis Talc (by weight).

Preparation

Mix clear baking varnish with Loomis Talc to consistency of putty.

Application

Apply immediately and bake in oven at 115° C. for four (4) hours. After baking, paint cement with red air-drying enamel.

Ground test brush holder after baking and before storing or replacing in generator at 5000 volts.

* Maintain 1/8"+1/16"-0" clearance between bottom of brush holder and commutator. 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 the commutator. Brush holders should

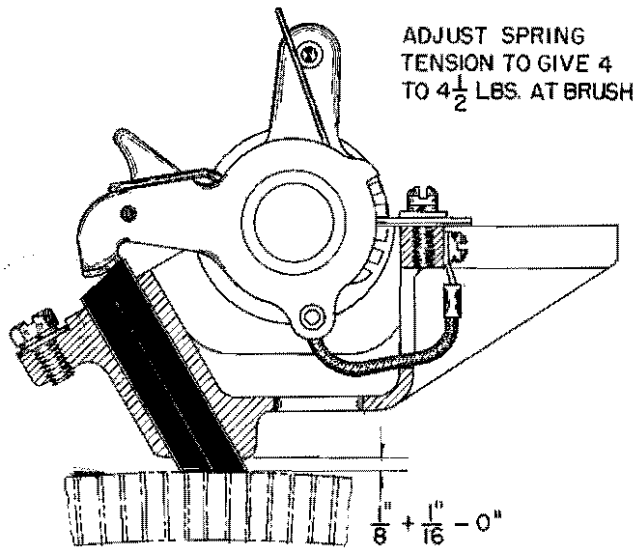

Fig. 6 - Brush Holder Clearance

be kept rigidly bolted in place. Refer to Fig. 6.

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

To Remove Lever And Shaft Assembly From Brush Holder

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.

To Reassemble Lever And Shaft Assembly To Brush Holder

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" shape tool as shown in Fig. 7 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. 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. Fig. 8 shows end bell and brush holder assembly.

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

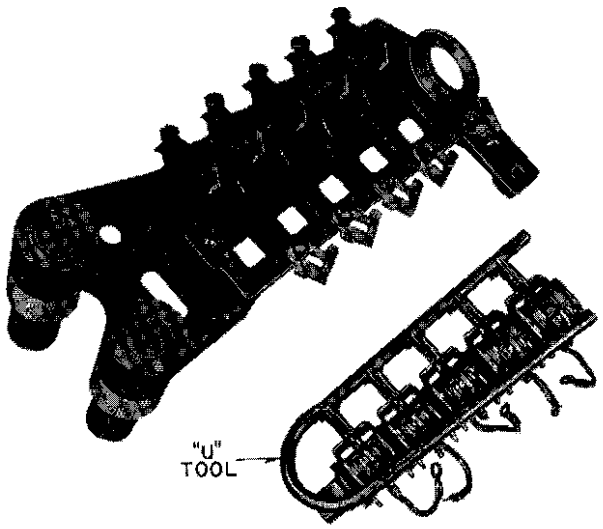

Fig. 7 - Installing Lever And Shaft Assembly

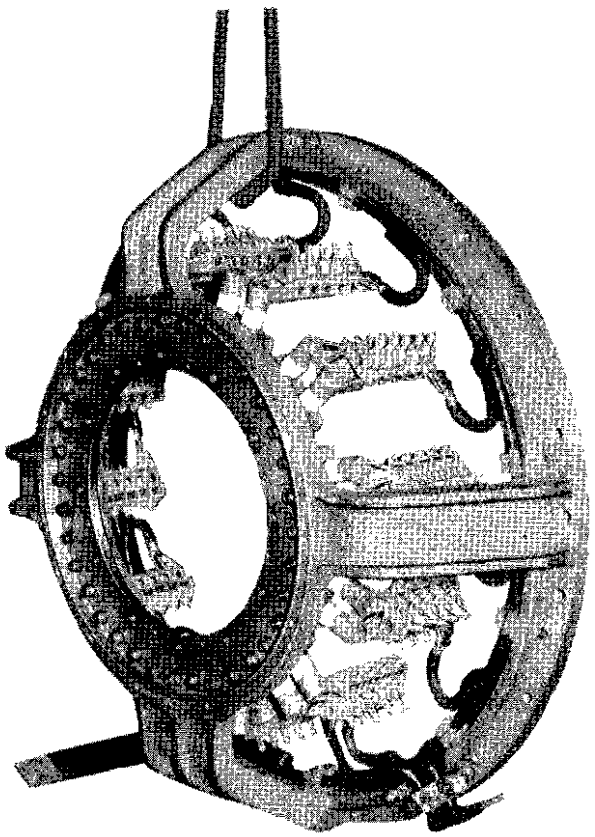

Fig. 8 - End Bell & Brush Holder Assembly

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 Electro-Motive Division.

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 is such that treatment is necessary and the proper facilities for vacuum impregnating are not available, return the generator to Electro-Motive Division.

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

Polishing The Commutator

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, designed to remove the undesired film, dirt and grease and does not affect the face of the brush or the commutator. Its cleaning action is like an eraser. 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.

Grinding The Commutator

In the event that the commutator is burned or pitted to the extent that the above procedure does not clean it, grinding will be necessary. The following is a suggested procedure to be followed in grinding a commutator, using the grinding fixture.

* 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 and grinder proper. 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

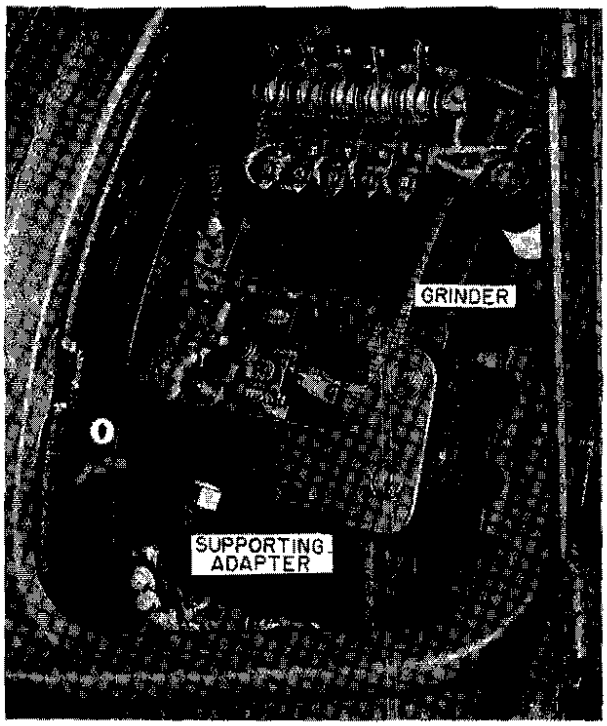

Fig. 9 - Commutator Grinding Fixture

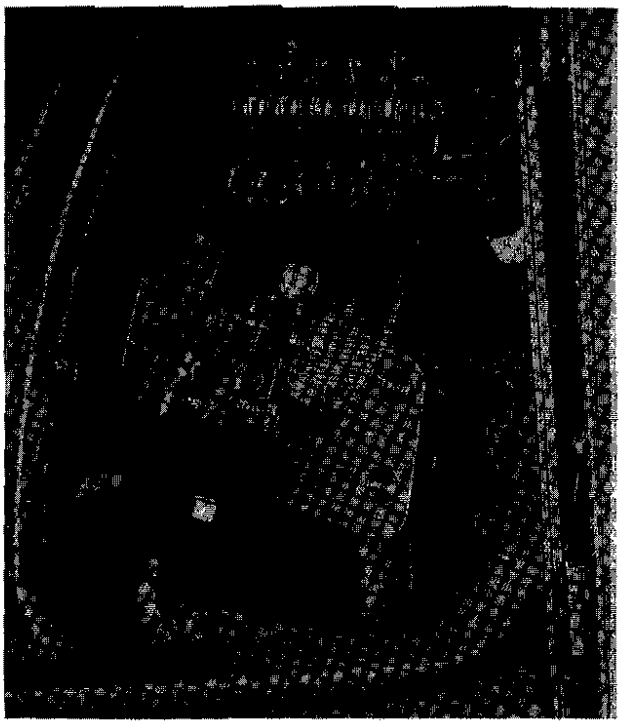

Fig. 10 - Aligning Grinding Fixture

shown in Fig. 9. Square the grinder up with the commutator as near as possible, so that the cross-feed will run parallel with the commutator bars. As a final check on this, mount an indicator on the grinder and check for parallel (should be within .001"), as shown in Fig. 10.

Next, mount stones -- be sure 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 into commutator slowly until light contact is made, then run stones across commutator. To finish, run stones across commutator several times without feeding radially.

After grinding the commutator, the generator should be cleaned thoroughly. First wipe all the loose copper off the inside of generator, so that a minimum of copper is blown into the windings. Next blow the generator out thoroughly. Special attention must be paid to complete the removal of copper from commutator slots. This can best be done by running the engine and directing 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 out whenever examination shows that bright mica is not visible. To clean, use a hacksaw blade that has had the "set" of the teeth ground off and that is of the proper thickness.

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

Turning The Commutator

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 (Diameter)

The Type D-12 generator commutator is designed to allow for 3/8" radial wear, which gives a minimum diameter of 34-1/4" as a condemning limit.

If the commutator has been subjected to misuse, it might become rough as it approaches the condemning limit, and the full amount of wear might not be obtainable.

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. No commutator neck diameter should be machined below that point.

Undercutting The Commutator

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 .031". When undercutting the width of the mica, a .031" undercutting saw #8085255 should be used.

Burr the commutator with a hand scraper after undercutting 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.

Overhauling The Commutator

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 very close attention, as well as many hours actual time 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

The proper care of creepage surface on the armature is extremely necessary to prevent flash-overs. Surfaces marked "X" in Fig. 11 are to be painted with Flintflex Red (153-0895) insulating paint whenever an inspection reveals the need. The recommended procedure is as follows:

1. Sandpaper the surfaces marked "X" and "A" and from "X" to "Y" with

00 grade sand paper. Sand smooth applying a light pressure when sanding over the commutator string band.

2. Clean surfaces thoroughly with alcohol.

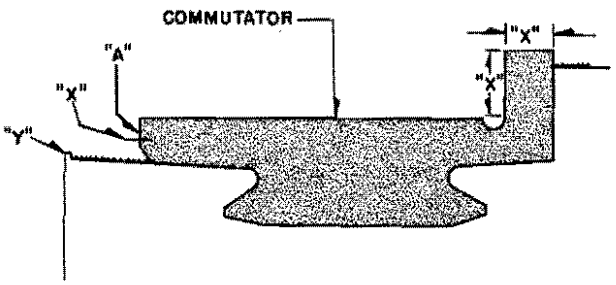

Fig. 11 - Care Of Creepage Surface

CAUTION: Do not paint over carbonized insulation with insulating paint or varnishes. When 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 cannot be made in the locomotive. Do not run 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, working the paint brush considerably so the paint will be evenly applied, leaving no dabs or overlapping marks.

4. Extra care must be taken to see that no paint gets into the commutator slots, the relief at the bottom of the commutator neck, or the surface marked "A" in Fig. 11. This trouble will be experienced if care is not taken in applying the paint or if the machine is run while the paint is wet.

5. 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. No thinner for the Flintflex is necessary if container cover is kept tight and application brush used is clean and free of old paint.

Generator Field Pole Assembly

Make a visual inspection of the condition of insulation on the main poles and interpoles for charred or damaged insulation, or any other unusual condition.

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

To remove a field pole or an interpole, the generator will have to be uncoupled from the engine and the complete generator and alternator assembly removed from the unit and placed on the shop floor. Raise the assembly off 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. Obtain a pole spacing measurement between the side of the main pole core and the side of the adjacent interpole cores, and record this measurement. These measurements will be of aid to obtain alignment of poles when re-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 Division for salvage value. 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 proper place as originally found.

It is also important that the generator pole spacing be aligned after reassembling and before soldering connector straps or cable connections 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 lie within plus or minus .010" of the average interpole air gap of that machine.

3. The spacing from a center line of one main pole to the center line of the adjacent main pole shall not vary from a nominal center line by more than 1/32".

All cable and connector joints other than interpoles and compensating field connectors are soldered with Hi-temp. solder #8004399. Compensating field connectors are soldered with solder #8004402. Shunt field coil lead connections are soldered with #8107868. Flux with Nokorode soldering paste before soldering. Braze all interpole connector joints using brazing tongs and Sil-Fos solder. Care should be taken to prevent solder from running down field conductors when performing any of the soldering operations.

Fig. 12 shows a generator field assembly.

Insulation Of Connections

Connections, straps and cable lead to coils, should be examined to determine if they are electrically satisfactory and secured mechanically.

Insulate all shunt field soldered connections with 3 layers of Empire tape overlapped and 2 layers of friction tape except the shunt field connection between coils 10 and 11 which are taped with 3 layers of glass and mica tape and 2 layers of friction tape.

Insulate battery field 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 with red air-drying enamel. After red enamel dries, paint with black air-drying varnish.

Starting and differential field connectors are not insulated after soldering joints. Paint with black air-drying varnish after soldering.

Those interpole connections next to the frame are insulated with 3 layers of Empire tape and 2 layers of friction tape, all taping half overlapped.

All loose lead connectors should be tied with 1/16" torpedo twine and fish paper insulators tied in where necessary, and painted with black air-drying varnish.

Compensating field soldered connections are not insulated with Empire or friction tape, but are sprayed or painted with black air-drying varnish. Fish paper pieces are installed between compensating field connectors on the commutator end and on rear end of

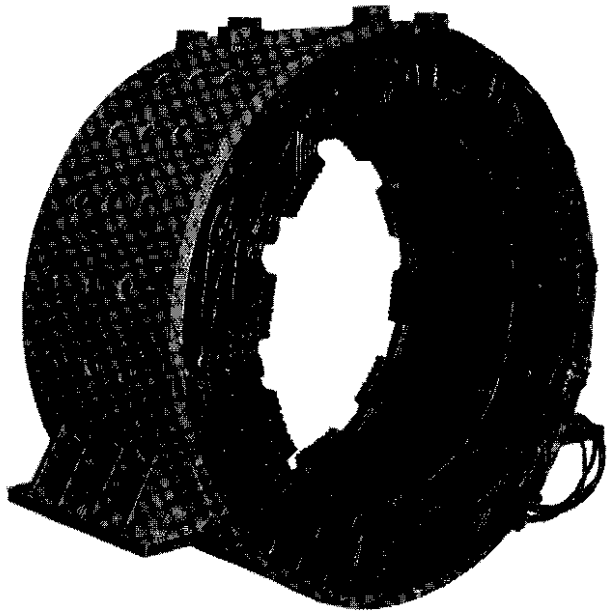

Fig. 12 - Generator Field Assembly

stator. Tie connectors in place with 1/16" torpedo twine as shown in Fig. 13.

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.

For high potential testing see Maintenance Instruction 2100.

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.

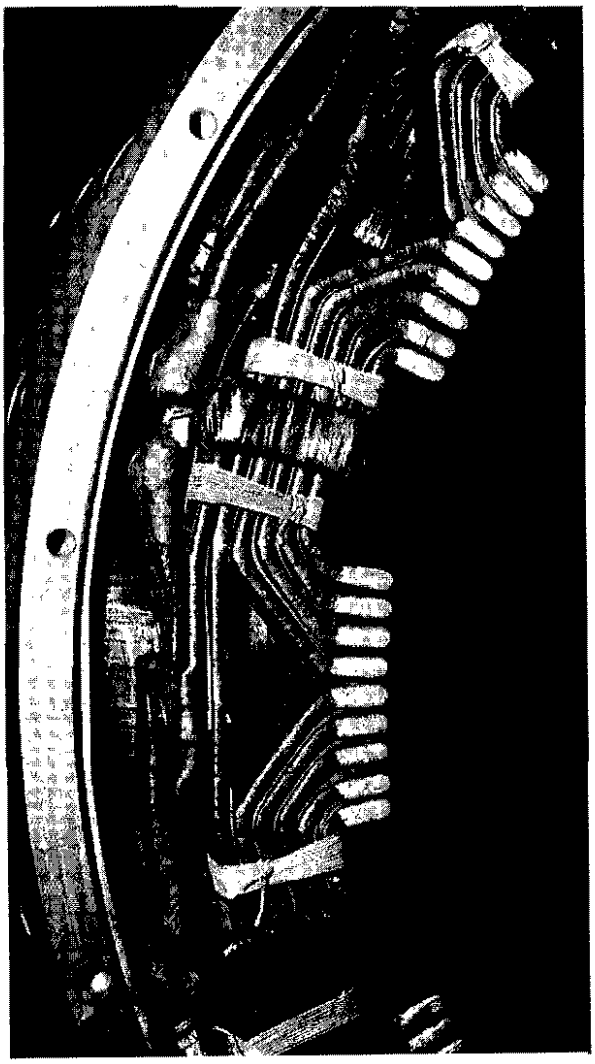

Fig. 13 - Compensating Field Connection

Make a resistance test of fields and interpoles with Kelvin Bridge, see wiring diagram, Fig. 14, and Maintenance Data for values.

Removal Of Armature And Roller Bearing Assembly (Generator Outside Of Unit)

It is assumed that the following operation has been performed before the generator and alternator assembly was removed from the locomotive unit:

1. That fish paper strips (1/16" × 3" × 36") are placed in the air gap between the armature and field poles of the direct current generator only. No material was used in the air gap between the alternator rotor and its stator.
2. That the brushes were removed from commutator and collector rings and the commutator protected with a ring made of fish paper material.

To Remove The Armature And AC Rotor From Stator Assemblies

Mount the generator alternator assembly on steel "I" beams at a suitable height from floor. Use anchor shackle and base fixture for lifting complete generator assembly.

Remove friction and Empire tape from bolted connections and remove bolts from busses. Remove cleats and straps bolted to the commutator cover assembly and remove the generator negative and starting field bus bar. Remove conduit pipe clamps bolted to the bottom commutator cover.

Remove collector ring brush holder cables to terminal post on compressor gear guard assembly and remove guard assembly. Remove commutator covers.

Apply arbor fixture to spider bore of alternator rotor.

Remove bolts from end housing to generator frame.

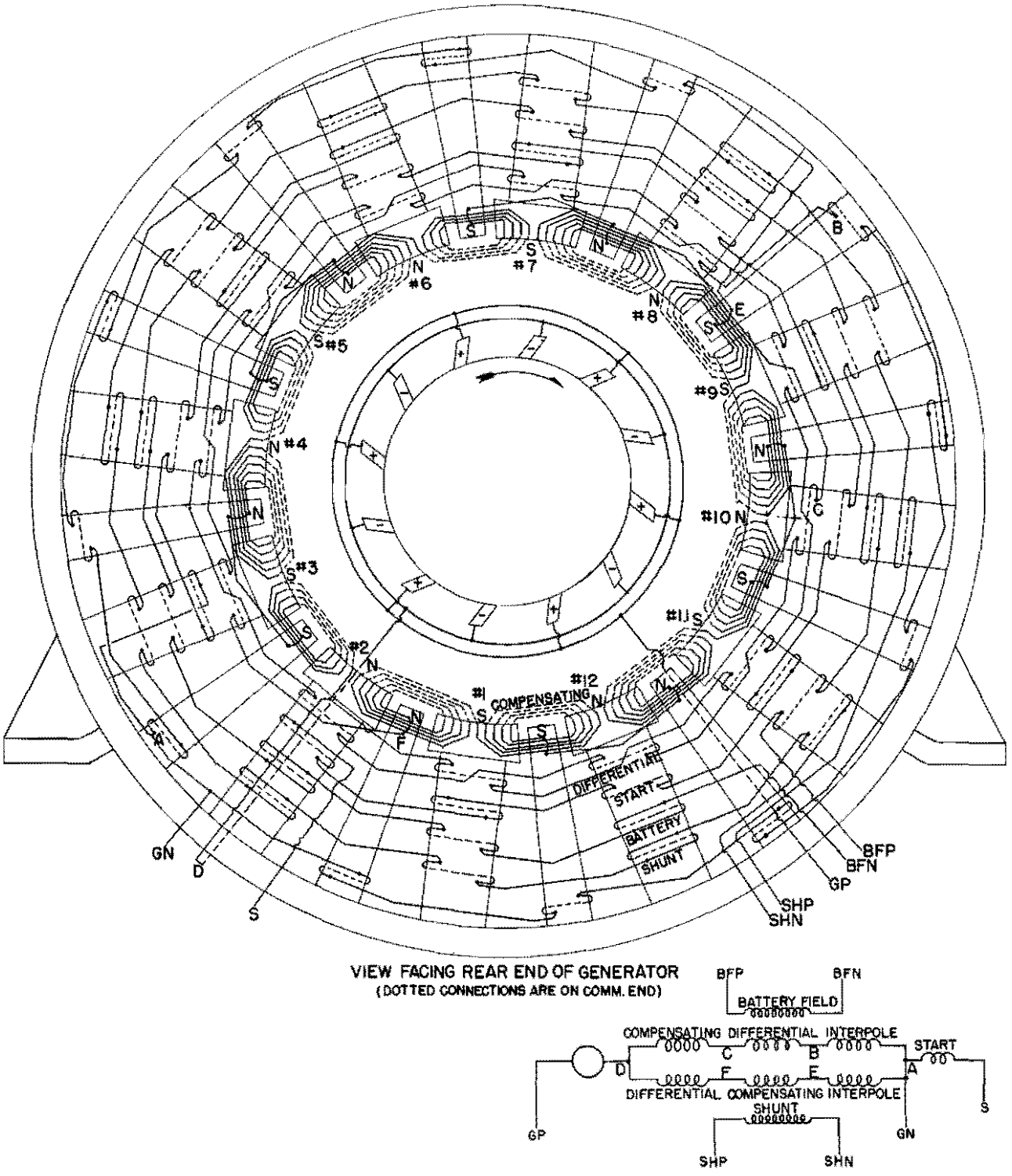

Fig. 14 - Wiring Diagram D-12 Generator

Apply two wire cable loops, place one loop around arbor fixture and the other loop around compressor coupling gear. With aid of crane raise back end and space the rotor air gap in the stator frame. With the aid of a second crane, the cable on the front end around compressor coupling gear should be raised until it is taut.

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.

Ease the armature and alternator rotor out of the frame toward commutator end. Care must be exercised not to injure the laminations or windings. Do not allow the armature to rub on the pole pieces while it is being removed.

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.

Remove bolts from gear seal plate to compressor gear, and remove gear.

Remove collector ring cable from terminal posts and remove bolts holding flange to generator shaft to remove flange.

Apply studs to the 1/2"-13 N.C. class 2 tapped holes, studs should be long enough to allow use of pulling plate or hydraulic puller to remove the coupling gear assembly from shaft. Remove collector ring brush holders from studs pressed in bearing cover.

Apply studs to the 7/16"-20 N.F. class 3 tapped holes, and remove sleeve from shaft.

Remove bolts from bearing cover and remove cover. The bearing housing may then be slipped off the bearing outer race.

To remove the remainder of bearing assembly, apply eight (8) studs of sufficient length to the 1/2"-20 N.F. class 3 spline nut pressed into the bearing cover. With the aid of a pulling plate 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 less studs are used.

For removal of alternator stator from main generator stator or for removal of alternator rotor from generator spider refer to Maintenance Instruction 430.

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 subject 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

Fatigue failures on the bearing surfaces are evident usually after failure of the material has started, as the actual failure almost always starts on the surface and is visually evident only after it progresses along the surface. Final failures of the material are usually evident as ragged centers 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 bearings which have been run. However, should a 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 question as to their detrimental effect on the 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 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

Bearings which show excessive wear of cages should be replaced.

Honing Bearing Housing

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 bearing and 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 in any way. 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, as the tolerance is such that if a bearing race were at the maximum allowable tolerance, and the housing bore was to the minimum allowable tolerance, the recommended clearance would not prevail.

Bearing Dimension And Tolerance

Outer diameter	11.0236"	+ .000" - .0014"
Bearing bore	5.1181"	+ .000" -.0010"
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 (armature bearing in housing)	5/16"	

* To Assemble Armature Bearing Assembly To Shaft

1. Remove old grease from bearing cap and cover. Clean bearing cap and cover. Repaint with crankcase orange enamel paint and allow to dry.
2. Apply sealing grease to grooves in bearing cap and cover. N.L.G.I. #3 grease is approved. See Fig. 15.
3. Clean armature shaft, remove burrs or any gall marks.

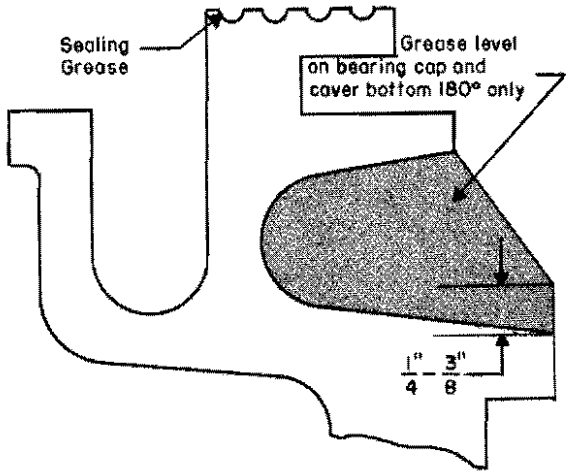

Fig. 15 - Application Of Grease To Cap And Bearing

4. Fill the bearing cap pocket with approved grease (Lubrico M-6 or Starfak #2) around the lower 180° to the level indicated by Fig. 15, and place the cap in position on the shaft as shown in bearing assembly drawing, Fig. 16.
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 as per instructions, shrink the oil thrower to the shaft. See Fig. 16 for proper position on the shaft. Let the oil thrower cool to room temperature.

NOTE: If an induction heater is used to heat bearing assembly parts. Overheating may result in warping or metallurgical upsetting of the parts.

6. Fill the bearing with the approved grease. The outer race may be moved to any position. Pack the bearing rollers and the space between the two groups of rollers completely with grease.
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" of the total indicator reading.
9. Apply two studs #8159226 180° apart to the 1/2"-20 N.F. 3 thread spline nut which is pressed in place to 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 such as N.L.G.I. #3 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. Prior to the application of the end housing assembly over the roller bearing. Aligning tool #8159227 should be applied to the shaft to hold the bearing outer race stationary and to assist in applying the end housing over the roller bearing. Fill the grease pipe and grease grooves in the housing and housing core with the recommended grease. Apply the 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. 15. 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 hous-

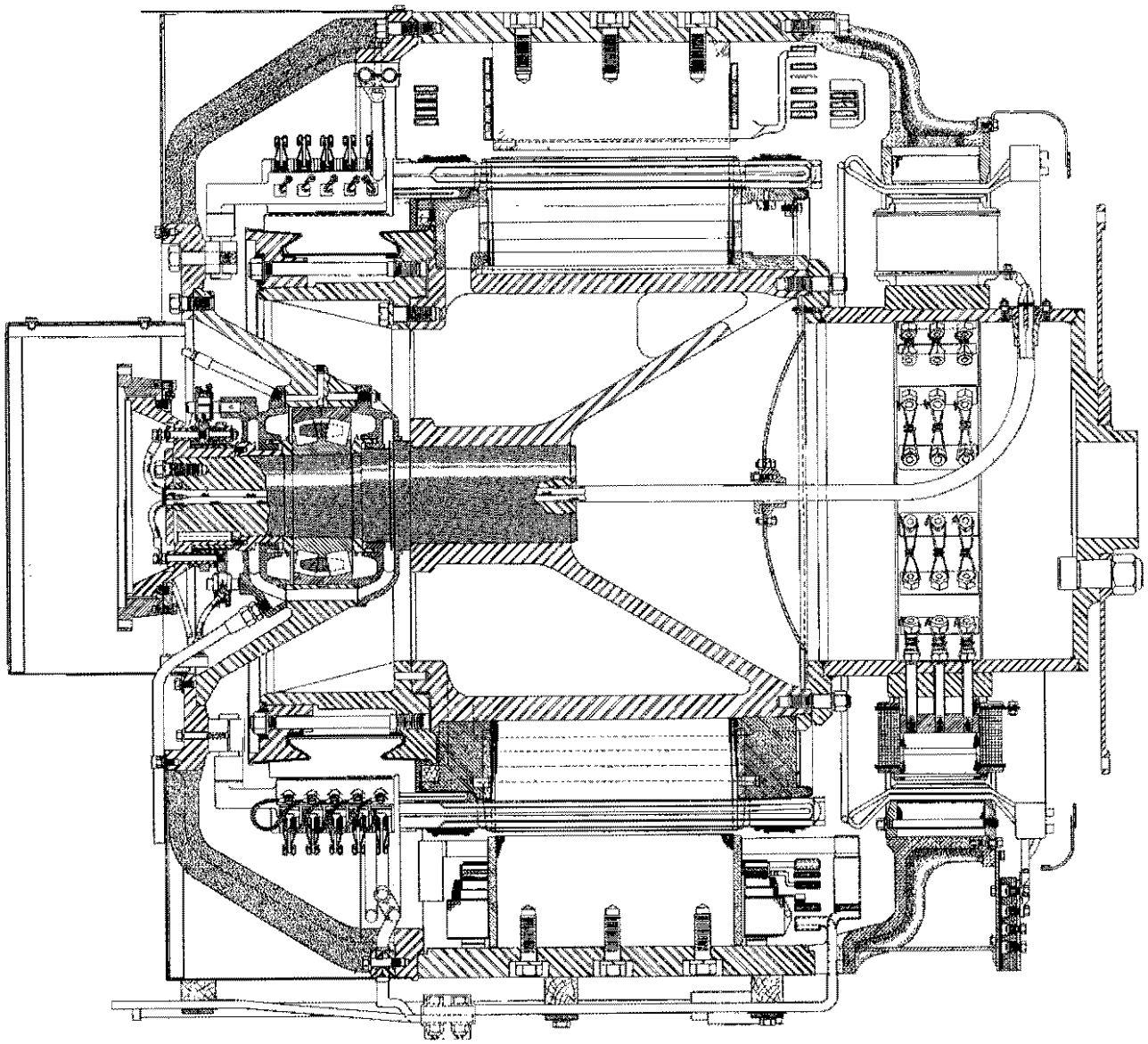

Fig. 16 - Cross-Section View Of D-12 Generator

ing drain hole. Remove the two studs used previously for aligning assembly parts.

13. Heat armature shaft sleeve on induction (pinion) heater to 260° F., or 127° C., and shrink to shaft. See Fig. 16 for position on shaft.

14. Apply collector ring brush holders to studs on bearing cover. Raise brush holders to clear rings before shrinking compressor coupling gear assembly to shaft.

15. Place coupling gear assembly on induction heater to expand. Heat to 248° F., or 120° C., taking pyrometer readings off slip ring. Clean key way and assembly key to shaft. Before shrinking gear coupling assembly to shaft, apply gear seal ring over collector rings; use new felt seal and gasket with ring. Shrink coupling gear assembly to shaft, for position. (See Fig. 16).

16. Fit cables through alternator conduit bushing in flange; bolt flange to shaft.

17. Cut cables and skin. Allow enough slack in cables to clear bolt heads. Solder terminal lugs to cables, wrap and tie cables with torpedo twine. Assemble terminals to proper post with flat washers, lockwashers and nuts. Paint cables with red air-drying enamel. (See Fig. 17).

18. Cover commutator with fish paper for protection and apply end housing and brush holder assembly to bearing housing. Line up hole of end housing assembly with bearing housing (one hole offset) and bolt assembly together.

19. Connect drain pipe to bearing cover and bolt with pipe clamp to end housing.

20. Apply compressor coupling gear over coupling gear assembly and bolt to gear seal plate.

Generator and Alternator Assembly

1. Bolt alternator stator assembly to generator stator frame.

2. Apply split brushes and bolt shunts from brush to brush holder. Sand-in brushes, preferably in direction of rotation. With a clean dry lintless bound edge cloth, clean carbon dust from commutator riser, string band and porcelain insulators.

3. Apply generator coupling disc to alternator rotor flange.

4. Place arbor fixture through flange bore of alternator rotor spider.

5. Use two wire cable loops, place one loop around the compressor coupling gear and the other loop around the arbor fixture. With the aid of two cranes, lift and guide the armature and alternator rotor into the stator

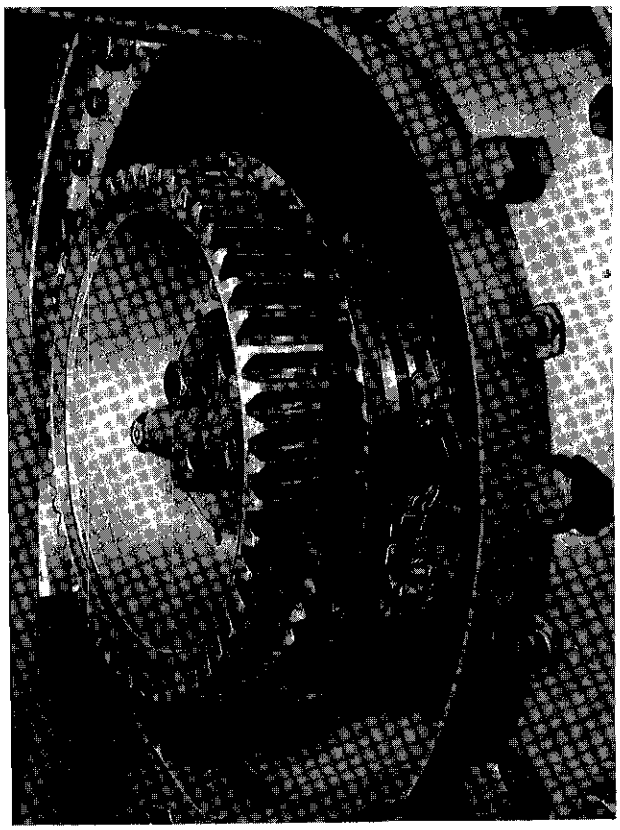

Fig. 17 - Compressor Coupling Gear And Slip Rings

assemblies. Guide the rotor assemblies slowly and carefully so as not to damage the coils or insulation.

6. Bolt generator end housing to frame being careful to start the dowel in end housing into frame first.

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

8. 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 bolting connection tight, insulate with 3 layers of Empire tape and 2 layers of friction tape and paint with one coat of black air-drying varnish.

NOTE: All bus bar connections are to be clean before bolting.

9. Assemble commutator end covers and bolt in place. Apply cleats and straps to generator bus connection. Insulate bus bars from cleats and straps with red fibre insulation.

10. Apply compressor coupling guard assembly and bolt in place. Connect collector ring brush holder cables to terminal block on guard assembly.

CAUTION: Connect cable leads from brush holder of same polarity together 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 2100 for testing generator in locomotive.

Before high potential tests are made it is highly desirable to check first with a megohmeter. A megohmeter reading of less than 3 megohms should be viewed with suspicion and individual circuits checked to find location of the low resistance. 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	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 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 and Alternator

It is absolutely necessary that the armature be blocked under a stud 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 traction 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 of generator.

Installation of Main Generator and Alternator in Locomotive Unit

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

Before a main generator is installed, if it is a new generator or the original generator, 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, line up 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. All coupling bolts should be checked to see that they are smooth and clean. Place a little oil with white lead on bolts. 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 armature and 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 apply dowels or tighten base bolts until the next procedure, aligning generator with engine, is finished.

Aligning Generator and Alternator With Engine in Locomotive

The alignment of generators 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.

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.

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

*Procedure For Aligning Generator Bearing In Housing

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. 18.

1. Remove one oil pan hand-hold cover and take out all the crankshaft thrust by prying against a crankshaft web and the 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.

   a. On locomotives having a 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. 18, 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 whether a coupling or type of coupling is used between generator and compressor, make a measurement as listed under 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.

*Procedure Of Generator And Alternator Alignment With Engine

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.

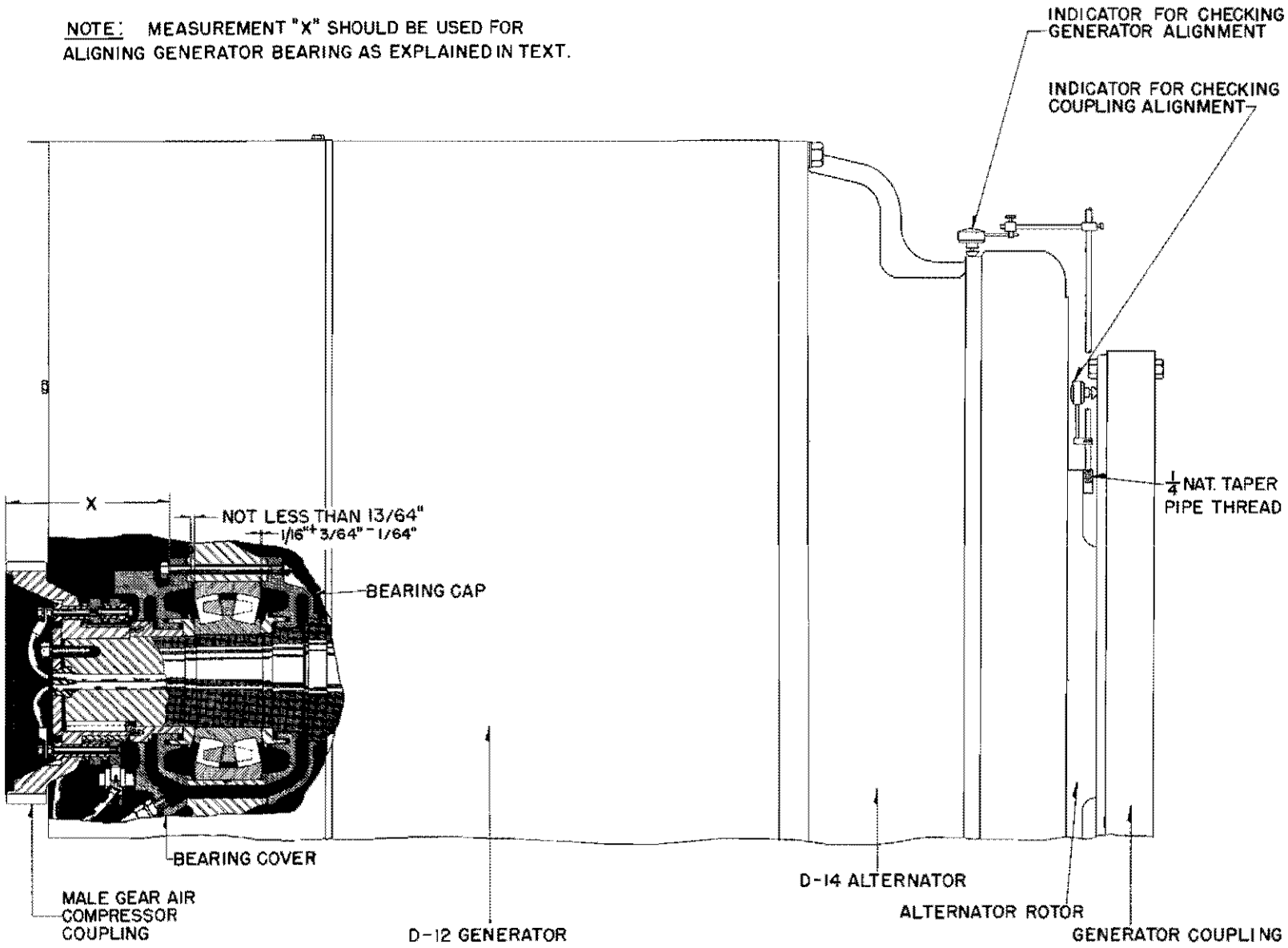

Fig. 18 - D-12 Generator Alignment

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

(a) Neutralizing the angular misalignment of the generator engine disc coupling.

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

1. By means of two indicators mounted on a rod which is screwed into a tapped 1/4" pipe thread hole in the D-14 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 on to the housing, see Fig. 18.

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. 18. 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 the clockwise direction, when facing commutator of generator; then rotate the flywheel three-quarter revolution in counterclockwise direction. (The reason for the counterclockwise rotation instead of continued clockwise rotation is to prevent the indicators from striking the alternator terminal board). From the three-quarter counterclockwise 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 (5) revolve the flywheel three-quarters of a revolution in a counterclockwise 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. 19.

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 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.

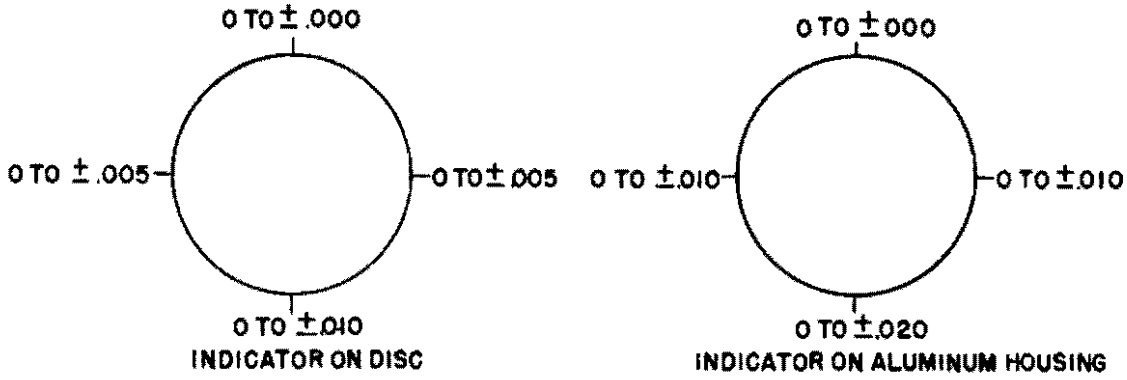

Fig. 19 - D12 And D14 Generator Alignment

Install generator — to — underframe dowels and lock generator bolts with lock plates.

Air Compressor Drive Alignment For Locomotives 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. 20.

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 in coupling and accompanying overloading of bearings in air compressor, the compressor must first be located to give a clearance dimension of 7/32" ± 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. An air compressor aligning tool #8133046 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.

Attach two dial indicators to the tool post, the button of one indicator riding the outer rim of the compressor flange to check radial alignment, the button of the other indicator riding the face of the compressor flange,

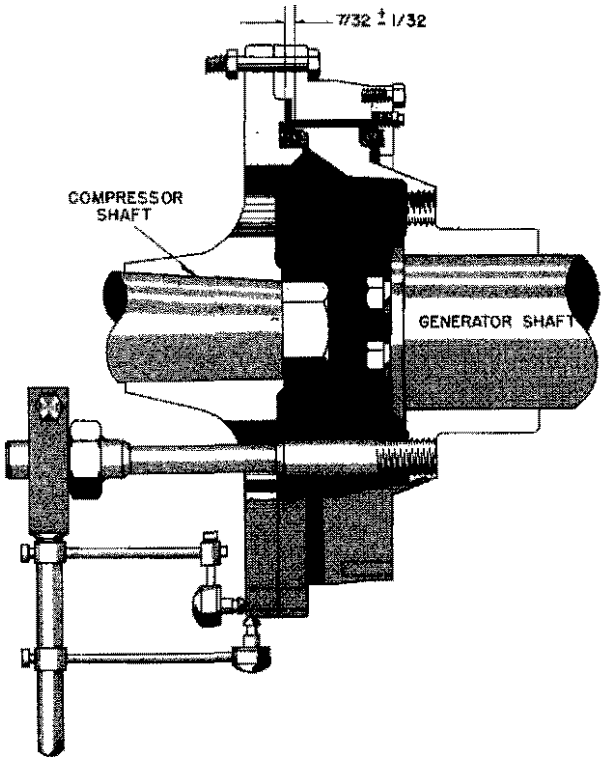

Fig. 20 - Air Compressor And Generator Alignment

toward the compressor, to check the angular alignment.

5. Rotate generator shaft and compressor shaft together, either by rotating each the same amount or tying the two units together in such a way that compressor alignment will not be sprung. 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" of total indicator reading. Total runout between face of generator gear and face of compressor flange 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 consistancy 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 lubrication will not eliminate this noise and in doing so there is danger of rupturing the felt seals, thus allowing lubricant to flow over alternator slip rings and brushes.

MAINTENANCE DATA

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"

* Brushes

Number of brushes per arm	5 Sets (split)
Size of brush	5/8" × 1-5/16" × 2-9/16" (Long Side) 5/8" made up of two brushes each 5/16" thick
Wear limit	1-9/16" on Long Side
Grade	Plytek SA-3590
Type	Split
Spring pressure - - - (low limit with worn brush 3-1/2 lbs.).	4 to 4-1/2 lbs.

*Brush Holder

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

Commutator

Minimum diameter	34-1/4"
Neck width (minimum)	3/4"

Mica groove depth	3/64" to 5/64"
Mica groove width	.031"

Resistance At 25° C.

Armature	.00261 ohms
Armature (1-10)	.00175 ohms
Shunt field (SHP to SHN)	~~92.0~~ 79 ohms
Battery field	1.0047 ohms
Starting field	.00480 ohms
Interpoles	See Fig. 14
A - B	.00186 ohms
A - E	.00188 ohms
Compensating	See Fig. 14
C - D	.00307 ohms
E - F	.00305 ohms
Differential	See Fig. 14
B - C	.00115 ohms
F - D	.00115 ohms
Total Resistance A to D (From generator negative terminal to generator negative brush holder ring connection)	.00385 ohms

Roller Bearing (D-12 Generators)

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

Hi-temp solder	#8004399
Pure tin solder	#8107868
Tin base solder	#8004402
Brazing strip	#8084889
Sil-Fos solder (.050" × 1/8" × 20" strips)	#8004440
Red insulating enamel (Flintflex 153-0895)	#8061130
Black air-drying varnish	#8004439
* Commutator cleaning hand stone	#8149435
* Undercutting saw .031"	#8085255
Lubriko M-6 — 1 pound	#8102583
Lubriko M-6 — 10 pounds	#8102584
Regal Starfak #2 — 25 pounds	#8084000
Orange enamel paint	#8070856
Torpedo twine	#8004412
Empire tape	#8077241
White cotton webbing	#8075536
Asphalt insulating compound	#8004348
Fish paper (.025" × 40" × 48")	#8075555
Clear baking varnish	#8069880
Loomis Talc — 5 pounds	#8116184
Loomis Talc — 10 pounds	#8116052
Alignment rod	#8122000
Air compressor aligning tool	#8133046
* Studs	#8159226
* Aligning tool	#8159227
* Commutator grinder	#8052924
* Grinder adapter	#8122497
* Stone grinding (coarse — 2 required)	#8052925
* Stone grinding (finishing — 2 required)	#8052926