# SUMMER TRAINING REPORT

**SESSION:2019-20**

**ON**

**TYPES OF GENERATORS AND ITS CHARACTERSTICS , NO OF POLES, WORKING FREQUENCY, GENERATED VOLTAGE, NEUTRAL GROUND INSPECTION & TESTING**


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III YEAR

ELECTRICAL ENGINEERING

BBD. UNIVERSITY

# पर्यवेक्षक प्रशिक्षण केन्द्र

## उत्तर रेलवे, चारबाग, लखनऊ

### प्रमाण-पत्र

क्रमांक 190402 दिनांक 19.07.19

प्रमाणित किया जाता है कि श्री Abhinav Yadav

वर्ष/सेमेस्टर B.Tech. II yr. संस्था Babu Banarasi Das University

ने रेल इंजन कारखाना, उत्तर रेलवे, चारबाग, लखनऊ में दिनांक 17.06.19 से 16.07.19 तक,

वोकेशनल प्रशिक्षण के अन्तर्गत प्रोजेक्ट Types of Generators & its characteri-stics, No. of poles, Working Frequency, Generated Voltage, Neutral Ground, Inspection & Testing. को

सफलतापूर्वक पूर्ण किया।

पाठ्यक्रम समन्वयक

मुख्य निदेशक
पर्यवेक्षक प्रशिक्षण केन्द्र (यांत्रिक)

प्रधानाचार्य

प्रधानाचार्य
पर्यवेक्षक प्रशिक्षण केन्द्र
उत्तर रेलवे, चारबाग, लखनऊ

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# INTRODUCTION

## Generators – Working, Types & Advantages

Generator is a machine that converts mechanical energy into electrical energy. It works based on principle of faraday law of electromagnetic induction. The faradays law states that whenever a conductor is placed in a varying magnetic field, EMF is induced and this induced EMF is equal to the rate of change of flux linkages. This EMF can be generated when there is either relative space or relative time variation between the conductor and magnetic field. So the important elements of a generator are:

- Magnetic field
- Motion of conductor in magnetic field

### Working of Generators:

Generators are basically coils of electric conductors, normally copper wire, that are tightly wound onto a metal core and are mounted to turn around inside an exhibit of large magnets. An electric conductor moves through a magnetic field, the magnetism will interface with the electrons in the conductor to induce a flow of electrical current inside it.

The conductor coil and its core are called the armature, connecting the armature to the shaft of a mechanical power source, for example an motor, the copper conductor can turn at exceptionally increased speed over the magnetic field.
The point when the generator armature first starts to turn, then there is a weak magnetic field in the iron pole shoes. As the armature turns, it starts to raise voltage. Some of this voltage is making on the field windings through the generator regulator. This impressed voltage builds up stronger winding current, raises the strength of the magnetic field. The expanded field produces more voltage in the armature. This, in turn, make more current in

the field windings, with a resultant higher armature voltage. At this time the signs of the sines depended on the direction of flow of current in the field winding. The opposite signs will give current to flow in wrong direction.

Types of Generators.

The generators are classified into types.

- AC generators
- DC generators

AC Generators:

These are also called as alternators. It is the most important means of producing electrical power in many of the places since now days all the consumers are using AC. It works based on principle of the electromagnetic induction. These are of two types one is induction generator and other one is synchronous generator. The induction generator requires no separate DC excitation, regulator controls, frequency control or governor. This concept takes place when conductor coils turn in a magnetic field actuating a current and a voltage. The generators should run at a consistent speed to convey a stable AC voltage, even no load is accessible.

Synchronous generators are large size generators mainly used in power plants. These may be rotating field type or rotating armature type. In rotating armature type, armature is at rotor and field is at stator. Rotor armature current is taken through slip rings and brushes. These are limited due to high wind losses. These are used for low power output applications. Rotating field type of alternator is widely used because of high power generation capability and absence of slip rings and brushes.

It can be either 3 phase or two phase generators. A two-phase alternator produces two completely separate voltages. Each voltage may be considered as a single-phase voltage. Each is

generated voltage completely independent of the other. The three-phase alternator has three single-phase windings spaced such that the voltage induced in any one phase is displaced by 120° from the other two. These can be connected either delta or wye connections. In Delta Connection each coil end is connected together to form a closed loop. A Delta Connection appears like the Greek Letter Delta (Δ). In Wye Connection one end of each coil connected together and the other end of each coil left open for external connections. A Wye Connection appears as the letter Y. These generators are packaged with an engine or turbine to be used as a motor-generator set and used in applications like naval, oil and gas extraction, mining machinery, wind power plants etc

Advantages of AC Generator:

- These Generators are generally maintenance free, because of absence of brushes.
- Easily step up and step down through transformers.
- Transmission link size might be thinner because of step up feature
- Size of the generator relatively smaller than DC machine
- Losses are relatively less than DC machine
- These Generator breakers are relatively smaller than DC breakers

DC Generators:

DC generator is typically found in off-grid applications. These generators give a seamless power supply directly into electric storage devices and DC power grids without novel equipment. The stored power is carries to loads through dc-ac converters. The DC generators could be controlled back to an unmoving speed as batteries tend to be stimulating to recover considerably more fuel.

Classification of DC Generators

D.C Generators are classified according to the way their magnetic field is developed in the stator of the machine.

- permanent-magnet DC generators
- Separately-excite DC generators and
- Self-excited DC generators.

Permanent magnet DC generators do not require external field excitation because it has permanent magnets to produce the flux. These are used for low power applications like dynamos. Separately-excite DC generators requires external field excitation to produce the magnetic flux. We can also vary the excitation to get variable output power. These are used in electro plating and electro refining applications. Due to residual magnetism present in the poles of the stator self-excited DC generators can able to produce their own magnetic field ones it is started. These are simple in design and no need to have the external circuit to vary the field excitation. Again these self-excited DC generators are classified into shunt, series, and compound generators.

These are used in applications like battery charging, welding, ordinary lightening applications etc.

Advantages of DC Generator:

- Mainly DC machines have the wide variety of operating characteristics which can be obtained by selection of the method of excitation of the field windings.
- The output voltage can be smoothed by regularly arranging the coils around the armature .This leads to less fluctations which is desirable for some steady state applications.
- No shielding need for radiation so cable cost will be less as compared to AC.

## MAINTENANCE PROCEDURE

The technical particular of traction generator are complied here, with particular reference from the maintenance angle. It may also be noted that there is nothing common between DC generator and Traction generator from interchangeability point of view, expect the main bearing, its housing, distance piece and cap.

| | |
|---|---|
| GENERATOR | Type **TA10102CW** is a 10pole Y-connected AC generator |
| Continuous rating For application on WDM2c/WDG-2WDP2 Locomotive | HV 1100 Volts, 1760 Amps.1050 Rpm<br>LV 525 Volts, 3700Amps, 1050 Rpm |
| Characteristics curve | as per the figure given |

Resistance at 25 deg Celsius (Designed values)

| | |
|---|---|
| Stator | 0.002156 ohm (Line to line) |
| Rotor | 0.312 ohm (at slip rings) |

**BRUSH GEAR**

| | |
|---|---|
| No of brush Arm | 2 |
| Brush holder/Arm | 2 |
| Brush Grade | HM6 of Morgans |
| Size of brush<br>mm to fig.0.7 | 25.4 mm x 38.1 mm x 50.8 |
| Spring pressure | 1.36 to 2.2 Kgs (adjustable)<br>To be adjustable 1.8 Kg |
| Clearance between brush Holder& slip ring | 2 to 3 mm |

**BEARING**

| | |
|---|---|
| No of slip rings | 2 steal slip ring |

| | |
|---|---|
| Diameter(New) | 520 mm |
| Minimum outdia | 510 mm |
| Slip ring run out (max) | 0.1 mm |
| **ROTOR** | |
| Diameter | 1003 mm |
| Air gap at pole center | 6 mm |
| Rotor bearing | NU 330EW/CA/D150mmX65mmX320mmO/D |
| Bearing housingdimension | 320-0.005 mm |
| Where outer race sits | -0.025 mm |
| Radial clearance of free bearing when new | 0.65 to 0.215 mm |
| Fit b/w outer race & Bearing housing | 0.035mm clearance<br>0.025mm interference |
| Shaft bearing seating dia | 150+0.055mm+0.035mm |
| Fit b/w inner race &shaft | 0.035 to 0.08 mm interference |
| Diametrical slackness of Free bearing | 0.15 to 0.18 mm |
| Min. permissible Clearance when assembled | 0.03 to 0.13 mm |
| Minimum diametrical Clearance when assembled in the machine | 0.051 mm |
| Gear box oil capacity | 2.6 litres approx. |
| Lubricant type | SAE 40 or equivalent |
| End shield spigot dia where Gear box locates | 495.3+0.051mm+0.011 |
| Gear box seating dia.it locates on end shield | 495.3+0.076mm+0.00mm |
| Rotor fan I/D | 600 +0.070mm+0.00 |
| Rotor fan seating dia | 600 +0.122mm+0.078 |

## WEIGHTS

| | |
|---|---|
| Traction generator complete With AG's & PTU | 6507 kgs |
| Traction generator with only | 5580 kgs |
| TA rotor | 2400 kgs |
| Each Aux Generator | 435 kgs |
| Gear case | 175 kgs |
| Power Take off Unit | 63 kgs |

Traction Generator is coupled with Diesel Engine to generate electrical energy, which is fed to the D.C. traction motors through associated controls.

**Salient Features of Traction Generators**

1. Large diameter with short armature core length to render compactness.
2. Single bearing, engine frame mounted as well as double bearing, foot mounted designs.
3. Series windings provided for cranking of diesel engine.
4. Compound winding provided for improved controls.
5. Hollow armature shaft for weight reduction.
6. Open commutator risers for improved armature ventilation.
7. Brush-rocker assembly to facilitate maintenance.
8. Brazed armature coil to commutator riser connection joints.
9. Micalex brush holder pins.

## MAINTENANCE DATA

At the outset, it may be mentioned that the routine maintenance of Traction generator is much simpler due to the absence of commutator and burn gear arrangement.

Routine maintenance of Traction generator therefore mainly include periodic cleaning and inspection of the machine the including brush gear and carbon brushes pertaining to slip rings.

It is recommended that the period of inspection should be more frequent in the initial period of service, and schedule can be subsequently relaxed based on experience. The inspection and maintenance described here is generally for monthly schedule.

It is also recommended to keep a record of brush wear rate which can be used to predetermine the carbon brush replacement period

### A. CLEANING

Clean all the loose dust and dirt from the exterior of the generator, taking special care at the areas around air opening and inspection covers.

Remove the inspection covers and wipe out any loose dust from the slip ring and gear areas. Vacuum cleaning of the machine is recommended, but if vacuum cleaners are not available dry compressed air can be used but care should be taken to make sure that the dust is blown out of the machine.

The generator,unlike the traction generator,is less prone to collection of dust and carbon. Therefore, except in some very dusty areas in summer months, air blowing of the machine once a month is adequate.For air blowing, remove the inspection covers on the slip ring end and blow out the alternator with dry compressed air at low pressure 2-4 kg/cm.sq. Direct the air to remove dust from the stator winding and field coils.Where the use of low air pressure and dry cloths proves ineffective in removing embedded deposits of dirt, stiff brush soft wood or fiber shapers may be used. Wipe the slip ring insulation and approachable parts of the rotor field coils and components. Best way of cleaning is too moist a clean cloths with solvent for wiping.

Recommended cleaning solvents are given in IB-509 while cleaning look for any defects rotor spots or abnormalities for taking corrective action.

## B.PERIODIC INSPECTION

Periodic inspection should be carried out after thorough cleaning and following points should be cared.

1. Inspect the brushes for wear, replace worn out or brushes with broken pigtails. Be sure that the brush length is inspection.
2. Inspect the brush holders for any damage or loss of spring tension.Replace the brush holders if necessary.
3. Move the brushes up and down to release carbon dust or any foreign particles and to ensure free movement of the brushes.
4. Check machine interior for any traces of oil leakage from the gear box. If the leakage appears to be significant the sealing felt should be changed.
5. Check oil level in the gear box and maintain the level within the limits marked on the dipstick rod.
6. Check cables and connections for cracks or frayed insulation, ensuring complete security.
7. Ensure that there are no loose nuts or bolts in the machine and securely close the inspection cover.f

## C. PERIODIC TIGHTENING OF BOLTS

To be done every two to three months for the following assemblies in addition to routine inspection check.Carry out with specified torque value.Refer maintenance data for values.

- Auxiliary m/cs to gear case
- Gear case to alternator end shield
- End shield to stator frame
- Cable connections to generator
- Make a visual inspection of bolts which hold the terminal connection box cover in place. Also, examine the rotor lead junction box for any loose connections. Ensure tightness of all electrical connections.Cable connections to the RYB

terminals and brush holders should be intact. Using dry cloths wipe away accumulation of dirt.

Make a visual inspection for evidence of loose or missing auxiliary machine PTUmountingbolts,gear case mounting bolts on generator end shield and end shield mounting bolts on alternator body.Look for loose,damaged, or missing latches on inspection covers.

Replace any cracked spring/lock washer or any damaged bolt and also check locking of the remaining bolts in rotor

**D. INSULATION CHECK.**

Every four to six months, check the insulation resistance of the rotor and stator with a 1000 volts meager and record the IR value. The generator can be safely operated with a minimum hot insulation resistance of 1 to 2 mega ohms accumulation of moisture in the machine leads to low insulation resistance, then the machine needs prolonged drying at low temperature of 100-110 deg. Celsius till the insulation improves.

**CAUTION:**

1) While checking with 1000 volts meager shorten all ac and dc bus bars to avoid damage to the diodes.Remove the short after meager checkheck.

2) Do not apply any high potential test to the alternato generator in adiesel locomotive shed.

**E. RE-LUBRICATION**

After a year of service, the change the lubricating oil in the gear box with a fresh one .This is to be done in addition to all the checks above.

Check for oil leakage from the auxiliary-drive gear unit and around the auxiliary mounting flanges. Make sure the gear unit oil drain plug is tight and secured with the chain. The rubber O-ring should be replaced whenever the auxiliary machines/PTU is taken down.

Examine the machine interior for ingress of oil. Any trace of oil shows that the felt seal of the generator bearing housing is defective and needs replacements Replace the felt seal.

## F. BRUSH/ BRUSH HOLDER REPLACEMENT

### 1. BRUSHES

- Inspect for wear, and replace brushes which have reaches their condemning limit
- Look for chipped or broken brushes, brushes with loose broken or frayed pigtails and replace such brushes.
- Make sure the pigtails terminals are positioned properly and the pigtails terminal screws are tight.
- Move brushes up and down several times in the brush holders to release carbon dust or foreign matter from the carbon ways which may prevent free movement of the brushes.

### 2. INSTALLING NEW BRUSHES

When installing new brushes, make sure not to mix brush grades. Mixing brush grades in the same generator or changing to another grade can result in short brush life and damages slip rings. Install new brushes as follows:

- Insert brushes in the holder.
- Position the pigtail terminal under the terminal screw so that the terminal is parallel to the brush pressure arm.
- Tighten terminal screw and latch the brush pressure arm. The brush pressure should be 1.36 to 2.2 kg
- Because new brushes are already contoured to the slip ring. It is not necessary to seat them when they are first installed. Simply install them as described previously, and they are ready for operation.

### 3. BRUSH HOLDERS

- Check for loose,broken, bent or overheated pressure arms.Overheating will cause arms to become discolored and result in improper brush arm pressure.
- Make sure the helical spring is in position in the hooks.

- inspect brush-holder mounting and make sure the studs are tight.Check brush holder-to-slip ring clearance and adjust as necessary.

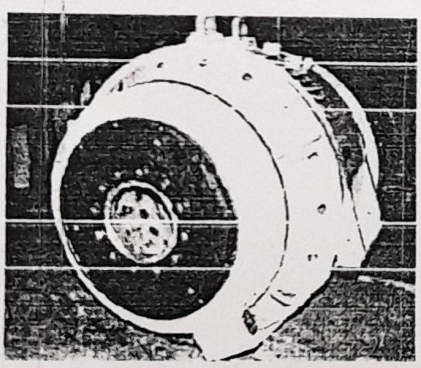
4. **ADJUSTING BRUSH-HOLDER CLEARANCE:**

Maintain clearance between the brush holders and the collector rings at 2 to 3mm. If the clearance is not within this range readjust the brush holders as follows:

- Remove brush from the holder
- Loosen the cap screw located on the brush holder and the slip ring.
- Move the brush holder down against the fiberboard shim and tighten the brush stud cap screw.
- Remove the fiberboard shim and replace brush in the holder. Make sure the pigtail terminal screw is tight and the pigtail is in the correct position.

## G.SLIP RINGS

A slip ring joviality of 0.1 mm max has been specified but as long as the brush operation is satisfactory, the vanity does not matter. However excess joviality can be removed during overhauling.



## PERIODIC OVERHAUL

The generator is required to be overhauled, even if the same is working satisfactory. The period of overhaul can be varied between 5 to 6 years depending on the conditions of operation and maintenance. However the first overhaul is recommended before completion of five years.

The routine consist overhaul completion of five years

1. Dismantling and cleaning
2. Inspection and Reconditioning
3. Replacement and Re-Assembly.

## DISMANTLING OF ALTERNATOR

Before undertaking dismantling generator, Examine its service history for any specific faults which may have to be attended during the overhaullt is recommended that, as far as possible, re-assemble after overhaul, the Remove same components which have been dismantled from the machine.

For dismantling refer Fig. 03 and proceed as follows.

1. Clean the Traction generator externally
2. Remove the drain plug from the gearbox and drain off oil.
3. Remove Aux.generator and exciter from the generator as follow:
    a) Apply a sling around the frame of the auxiliary machine or to the lifting eye bolt.
    b) Remove two bolts diametrically opposite securing the auxiliary machine to the gearbox and insert two guiding stud 1405976 item
    c) Remove the remaining bolts and withdraw the auxiliary machine to disengage auxiliary machine pinion from bull gear. Lower onto a suitable wooden Vee block.
4. Remove Power Take Off unit from the gearbox as follows:
    a) Apply a sling around the frame of the unit.
    b) Remove two bolts diametrically opposite, securing the unit on the gearbox
    c) Remove the remaining bolts and withdraw power take off unit and lower into a bench.
5. Remove the gearbox from the generator as follows :

a)Insert two eye bolts 1405978 item 2 into the tapped holes, used for securing the exciter to the gearbox.

b)Remove the three groups of two bolts securing the gearbox to alternator externally

c) Unlock the three groups of three bolts slip ring the gearbox to alternator by removing the locking wire. Remove the two bolts diametrically opposite band insert two guiding studs 1405976 item 2.

d) Remove the remaining bolts and withdraw the gearbox to disengage the idler gear from the bull-gear.

6. The bull-gear is to be removed by "Oil injection method" proceed as follows :

- Remove the plug sealing the oil injection hole, using screw driver.
- Mount the extractor for bull-gear 1405373.
- Screw the skink oil pump 1405980 into the oil injection hole in the shaft end and fill the pump reservoir with clean oil. Fit the reservoir to the pump.
- Open the pump relief valve and operate the pump until air bubbles cease. Close the relief valve and pump quickly so that pressure builds up before excessive leakage occurs. Now pull the bull gear with the extractor till it is released from the shaft.

7. Removing the distance ring :

Unlock and remove the bolts for the bearing retaining plate. Assemble the bearing retaining ring 1405368 over the shaft end and put bolts to the end shield through the bearing housing.

8.Remove end shield covers and insert fiber shims on top and bottom side between the rotor pole and stator core to maintain air gap concentricity during operations the use of shims prevent damage to gearing.

9. Insert the rope sling the blades of the fan and take slack in the sling.Unlock and remove the fan bolts and insert two guiding studs .

10.Assemle the frame lifting fixture on the end shield.

11. Remove the bearing retaining ring

12.Remove the end shield covers ,lift or remove all brushes and wrap thick paper around the slip rings for protection during handling.

## CLEANING WITH STEAM

a) Heat a washing compound in a steam tank (water and cleaning compound) until the temperature reaches 100 deg Celsius.
b) Place the parts to be cleaned in such a position that the steam can be directed from a hose in all direction for cleaning.
c) Clean parts and allow them to cool and blow compressed air for removing moisture.
d) For electrical components bake them till the moisture is removed.

## INSPECTION AND RECONDITIONING:

After the thorough cleaning of all parts, inspect and recondition as follows.

### A. ROTOR:

Check the rotor for any damaged or loose coils by tapping the coils by wooden mallet.

Check rotor field coil connections for looseness by tapping.

Check the slip ring insulation for any cracks or flaking.

Check the slip ring studs for any looseness or over heating etc.

Check rotor insulation resistance with a 1000volts megger and if value is more than 2M ohms no repair is needed to the rotor and then it is to be subjected to the following varnish treatment;

- Once again clean the rotor and the rotor coil surface and blow through the shaft barrel .
- Heat the rotor in an oven operating at 100 to 110 deg centigrade for 6 hours.
- Check insulation resistance and continue heating till IR is satisfactory.

- When the rotor is above the room temperature, apply two brisk coats of solventless resin, all over the rotor pole coils, pole body face and connections ring.
- Allow to cure the resin, once again check IR value should be greater then 2M ohms.

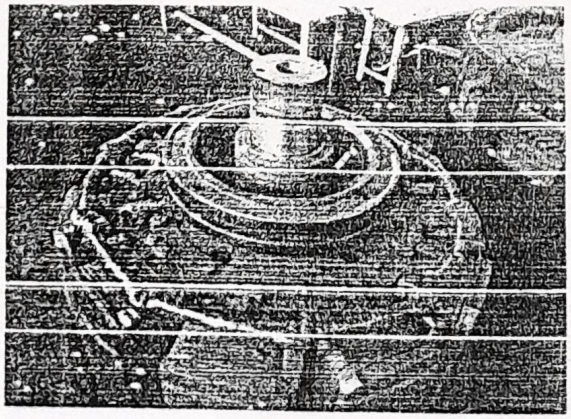


Fig.Rotor

## SLIP RING

Check the slip ring for smooth running surface, and for the soundness of insulation.See that the slip rings are not loose on the.Check the connections between slip ring and rotor pole coils and ensure tightness. If the slip ring is free from defects then apply two coats of epoxy red anti track paint on insulation surface and slip ring side walls. Second coating should be given afterdrying the first coat

Wipe off insulation between rings with a clean dry cloth ad inspect for evidence of physical damages.

Check the surface of the slip rings for evidence of discoloration, etching,grooving,threading,or other signs of damage.Ideally the slip ring surface should have a uniform shinning steel surfaceand free of etching , threading or grooving. Conditions encountered in service however including oil vapours adverse humidity conditions and air contaminants of various kinds adds to difficulty of maintaining and ideal slip ring surface .In addition other conditions which may also result in sparking and subsequent damage on slip rings are:-

a) Slip rings not running concentric with shaft .
b) Slip ring surface,rough or pitted.
c) Brush tight in brush holder.
d) Vibration of brush holder studs.

If the insulation to slip ring is damaged or the stud is flashed it is advisable to replace the slip ring or stud with a fresh one.

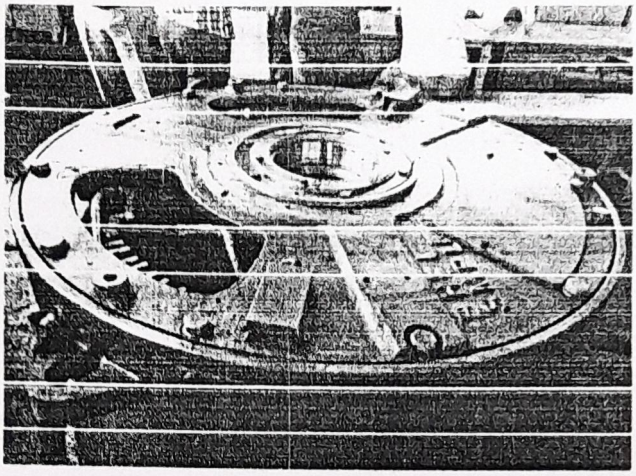


fig:STATOR

## RESURFACING SLIP RINGS:-

When inspection reveals that corrective maintenance is required resurface the slip rings by the following method depending on the severity of the burned spots or grooving :

a) With engine shut down ,remove all slip ring brushes.
b) Tap seater stone to the end of a stick for use.
c) Start the engine and run it at idle speed.
d) Apply enough pressure to the seater stone to produce the cutting action required to remove the dark or burned spots
e) Shut down the engine and reinstall brushes.

f) Stand brushes to remove metal which may have transferred from slip ring to the brush contact surface. Use of strip of long fine sandpaper for this operation

## C. BEARING ANDBEARING COMPONENTS

Check the oil level in the auxiliary –drive gear unit by means of the stick located on the lower right hand side of the gear case(facing slip ring end) between the exciter and the alternator frame head.

Maintain the oil levelbetween the MAX and MIN marks on the dip stick.

Do not overfill gear case. Overfilling may result in oil being drawn through the alternator bearing onto the slip rings and windings and cause serious operating difficulty . Make sure the filling cap is properly secured.

Examine bearing housing, distance ring, bearing cap for any dents,score marks. If they are of minor nature attend with a oil stone and rinse. If the damage is considerable replace with new components.

**a)** Examine the inner race for the followings:

1) Flaking or cracks in the roller path. If found,reject the bearing.
2) Heavy Electrical pitting.If found ,reject the bearing
3) Raised craters around the edges .Stoneoff
4) Mottled, distributed pattern of dirt denting .Scrap the bearing.
5) Evidence of rubbing or turning on the shaft .Look for loose spacers or interference of the housing parts. If rubbing is heavy or if there is wear on the shaft, reject the bearing.

**b)** Examine the outer race as follows

1) Look for evidence of spinning in the housing.If burning is severe,replace the bearing and bearing housing.
2) Slide one of the rollers around the race by hand. If the rollers drags,scrap the bearing.

**c)** Examine cages as follows:

1) Reset the bearing in vertical position and raise and lower the cage to check clearance.

2) Rotate the rollers to expose all surfaces. Look for heavy denting .Reject bearings if dent are found.

BEARINGS

**BRUSH GEAR:**

After thorough cleaning examine the brush gear components for any visible defects on brush holder ,bottom clamp or top clamp. If the defects or blisters are of minor nature attend to them with suitable filing/stoning. If the damage is considerable replace the affected or damaged components. Refer brush gear assemblyFIG.05 for guidance

Apply two brush coats of Red Epoxy anti-tracking paint on brush gear insulator pins, before re-assembly.

Check brush gear leads for any damage to insulation or crimped terminals.Replace if damage to insulation is noticed.

Traction generator gear box and bull gear wheel and pinion:

After dismantling and thorough cleaning of gear box bull gear wheel and pinions, refer the following

**IDLER GEAR ASSEMBLY:**

For re-assembly:

1. Assemble oil collector to idler gear shaft and tack weld bolt head to lock.
2. Assemble idler gear on to idler gear shaft.Ensure correct positioning of idler gear wheel.
3. Insert new "O" ring into the grooves on idler gear housing and shaft from inside of the gearbox. Keeping the oil groove in the shaft at lower portion ensure that the shaftssits squarely in seating of housing. Displacement of "O" ring in the gear housing can prevent this extra care has to be taken.

Assembly of pinions on to auxiliary machines, bull gear wheel, gear box are covered in the re-assembly instructions.

## RE-ASSEMBLY OF TRACTION GENERATOR

1. Fit the bearing collar onto the shaft, if removed ensuring that it is solidly upto the shaft abutment face. Assemble the felt seal after soaking with lubricating oil
2. Fit the bearing inner race by heating it to 100 to 110 deg. Celsius and shrinking onto the shaft .When cold tap the race to ensure that it is solidly upto bearing collar.Fit bearing races with the identification marks on both the inner and outer races being towards the outside of the machine.
3. Press the bearing outer race into the bearing housing after inserting the bearing inner cap. Assemble "O" ring in the bearing housing groove.Insert two guiding studs.
4. Fit the shaft adapter to the coupling flange. Insert eyebolt .Place a wooden block under the end of the shaft adapter and slowly lift the rotor with eyebolt turning the rotor to a vertical position.
5. Mount the end shield on the stator frame. Mount the frame lifting fixture and lift the stator frame by the fan end lifting lug on the frame and lifting lugs on frame lifting fixture.
6. Fit the guide sleeve over the end of the shaft.The guide sleeve aligns the bearing inner race with the rollers of the bearing outer race,and prevents damage to the bearing.

7. Lift the stator frame by the lifting lugs on the frame lifting fixture and lower over the rotor taking care not to damage the bearing or to allow the weight of the stator frame to be carried by the bearing housing and bearing collar. Place wooden blocks under the frame coupling lugs to support the frame weight.
8. Remove the guide sleeve from the shaft
9. Remove the bolts and assemble the bearing ring over the shaft and bolts to end shield and shaft. Tighten the bolts uniformly and with just sufficient force to take up any slackness between the retaining ring and bearing housing .
10. Insert shims on top and bottom side between the rotor poles and stator core through the end shield openings.
11. Lift the generator by two lifting lugs on the frame lifting fixture and on fan end of frame turning it to a horizontal position.Remove the bearing retaining ring. Remove the bearing frame lifting fixture.
12. Fit the plate locking washers and bolts fitting the oil spoiut under the lowest bolt. Uniformly tighten and lock the bolts.Fit the bearing retaining plate. Insert and lock the bolts.
13. Fit distance ring onto shaft solidly upto the bearing inner race.Shrink the bull gear onto the shaft after heating to 180deg. Celsius. Do not heat the gear above 190deg. Celsius. Immediately after the gear has been placed on shaft.follow up with the clamping ring to prevent movement of the gear away from the gearing distance ring as the gear cools down.
14. Insert the two guiding studs opposite into the fan mounting tapped holes of the shaft and fit the fan onto its spigot.
15. Remove the fibre shims inserted in between the rotor pokes and stator core .
16. Assemble the idler gear assembly on the gear case as follows
    a) Assemble the oil collector to the idler gear shaft.
    b) Lightly smear the shaft with molybdenum disulphide and assemble the idler gear onto the shaft.
    c) Insert the "O" ring into the groove in the housing and assemble the shaft and idle gear into the seating in the housing .Ensure that the oil groove in the shaft is in the lowest position. Make sure that the shaft sits squarely in its seating in the housing.
17. Refit Gear case as follows:

a) Insert gear case drain plug.

b) Insert two guiding studs [illegible] holes used for securing the gearbox to the end shield.

c) Insert the sealing "O" ring in the groove around the gearbox mounting flange.

d) Lifting by two eyebolts in the tapped holes used for securing the exciter to the gearbox, fit the gearbox to the frame spigot.

e) Insert and uniformly tighten the bolts securing the gearbox to end shield with specified torque and lock then with the locking wire.

f) Remove the guiding studs and insert the balance two bolts.

g) Fix the three groups of two bolts securing the gearbox to alternator externally.

18. Refit power take off unit to the gearbox in position.

a) Insert two guiding studs into the tapped holes in the gearbox.

b) Lift the PTU by means of a rope sling around the frame.

c) Insert the sealing "O" ring in groove around the mounting plate of the unit.

d) Assemble the power take off unit to the gearbox and insert and tighten all bolts.

e) Remove the guiding studs and insert balance two bolts. Tighten uniformly.

19. Assemble the exciter and auxiliary generator to the gearbox as follows.

a) Insert two guiding studs into the tapped holes used for securing thw auxiliary generator/exciter to gearbox.

b) Insert sealing "O" ring in groove around fan side end shield of auxiliary generator/exciter.

c) Fit an eye bolt in the lifting lug on the magnet frame of the auxiliary generator/exciter and apply a rope sling for lifting. Assembie on gear case.

d) Remove guiding studs and insert balance bolts. Tighten uniformly with specified torque.

## MAINTENANCE TOOLS FOR TRACTION GENERATOR

| SERIAL NUMBER | SPECIAL TOOLS |
|---|---|
| 1 | Bearing retaining ring |
| 2 | Clamping ring |
| 3 | Shift adapter |
| 4 | Guide sleeve |
| 5 | Frame lifting fixture |
| 6 | Lifting tackle |
| 7 | Force screws |
| 8 | Stud |