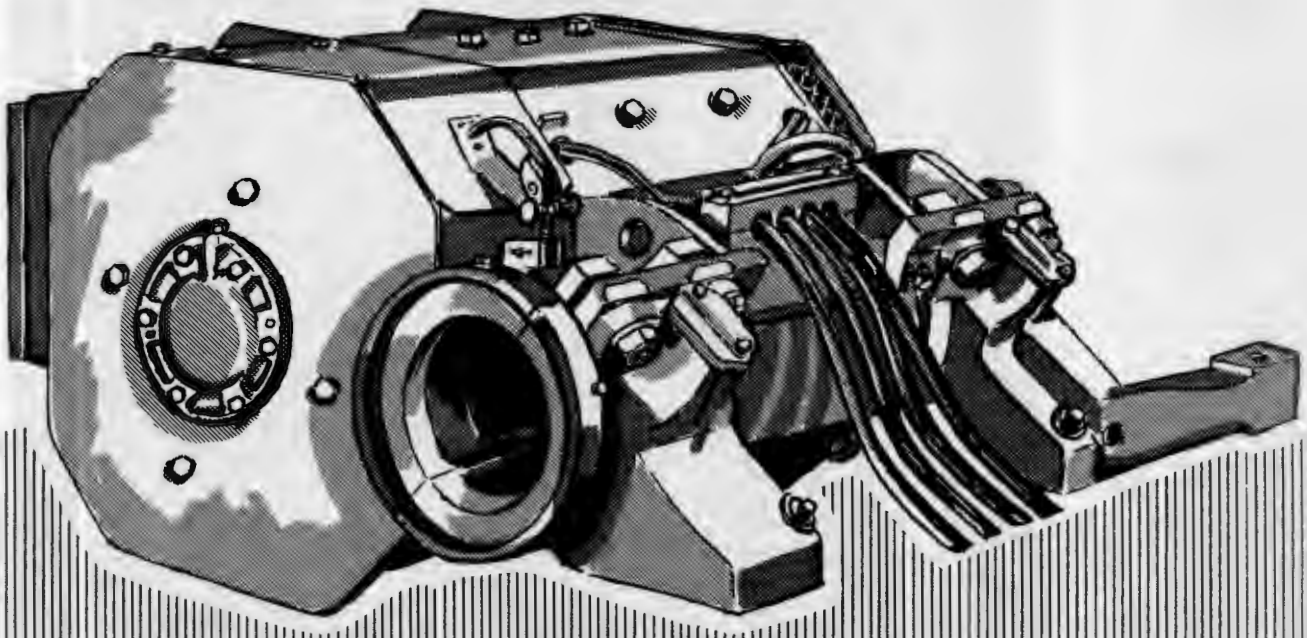
ELECTRICAL MAINTENANCE BULLETIN SEC. 411.5A

# FAIRBANKS-MORSE

# *Traction Motor*



**Westinghouse Types 362-D and 362-DF**

Dec., 1950

## FOREWORD

The purpose of this bulletin is to provide maintenance information for the particular piece of equipment named. These instructions do not, however, purport to provide for every possible contingency to be met in connection with the maintenance of this equipment. Neither is the amount of material supplied by Fairbanks, Morse & Co. increased by anything shown in these instructions or associated drawings. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purpose, the matter should be referred to Fairbanks, Morse & Co., Diesel Locomotive Division, Chicago, Ill.

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# TRACTION MOTOR, TYPES 362-D and 362-DF

## GENERAL DATA

### OPERATING LIMITS

| | |
|---|---|
| Maximum Safe RPM | 2500 |
| Maximum Volts | 800 |
| Maximum Amps | 1000 |
| H.P. Rating | 200 |

### BRUSHES

| | |
|---|---|
| Number of Brush Arms | 4 |
| Brushes per Arm | 3 |
| Grade of Brush | WP-11 |
| Size of Brush | 3/4x1-3/4x2" |
| Minimum Radial Length of Brush When Worn | 1-1/4" |
| Brush Pressure | 8 to 10 lbs. |
| Brush Holder Clearance (To Commutator Face) | 1/8 to 3/16" |

### LUBRICATION

| | |
|---|---|
| Armature Bearing Grease - Westinghouse PD No. 8750-1 | Fill bearings full<br>Fill caps 1/2 full |
| Lybyrinth Seal Grease - Westinghouse PD No. 2694 | |
| Axle Bearing Oil - Westinghouse PD No. 2088 | 1-1/2 to 3-1/2" deep |
| Gear Compound - Westinghouse PD No. 4577 | Keep bottom teeth covered |

### AIR GAPS IN INCHES

| | |
|---|---|
| Main Pole | 0.250 |
| Commutating Pole | 0.475 |

### RESISTANCES (Values Given in Ohms at 110° C.)

| | |
|---|---|
| Armature | 0.026 |
| Series Field | 0.017 |
| Commutating Field | 0.017 |

### COMMUTATOR WEAR LIMIT

| | |
|---|---|
| Minimum Diameter | 13-3/8" |

### WEIGHTS IN POUNDS

| | |
|---|---|
| Traction Motor with Pinion | 5,520 |
| Armature | 1,650 |
| Frame, Including Poles, Coils, and Brush Holders | 3,130 |

VENTILATION . . . . . Forced

## GENERAL DESCRIPTION

The traction motor converts the electrical power of the main generator into mechanical power to drive the locomotive wheels. It is a direct current, series motor. One side of the motor is supported by bearings on the locomotive axle, while the other side is supported by a nose on the motor frame, through springs, to the truck frame. See Illus. 1.

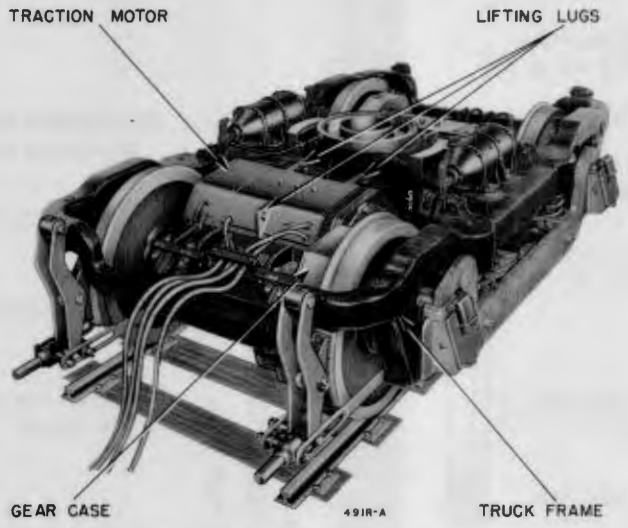
Two blowers, each being mounted in the locomotive and above a truck, supply cool air to the two traction motors in each truck. Each traction motor is connected to its corresponding axle through single reduction gearing. The armature is supported by a roller bearing assembly at either end.

The maintenance procedures for the two different types of traction motors referred to in this section are the same. The only difference between the two motors is that the armature coils on the 362-D motor are composed of two straps in parallel, while on the 362-DF motor the armature coils are composed of a solid single strap.

## GENERAL INSPECTION AND MAINTENANCE

The entire unit should be inspected at least once a month as a precaution against breakdown during operation. This inspection should include a thorough examination of the following:

1. Inspect the brushes and brush holders as explained under General Maintenance in the article entitled "BRUSH HOLDER ASSEMBLY".
2. Inspect the commutator surface as explained under General Maintenance in the article entitled, "COMMUTATOR".
3. Inspect the axle bearing caps to see that they are properly packed and none of the waste is glazed. Also, check the oil well to see that it contains no water and that the oil is at the proper level. Failure of the apparatus to comply with the above mentioned conditions will require repacking and refilling of the axle caps, as described in one of the articles following.
4. Check the axle bearings for wear as explained under Maintenance in the article entitled, "AXLE BEARINGS".
5. Inspect all connections to see that they are clean, secure, and making good contact.
6. Inspect the lubricant in the gear case as explained under General Maintenance in the article entitled, "GEAR CASE".
7. Inspect the armature bearing grease fittings to see that they are not damaged and permitting dirt to enter the bearings. For information on the periodic lubrication of bearings, refer to Section 203. Before adding grease, wipe the fittings clean, so that no dirt will be forced into the bearings.



Illus. 1. Traction Motor in Truck

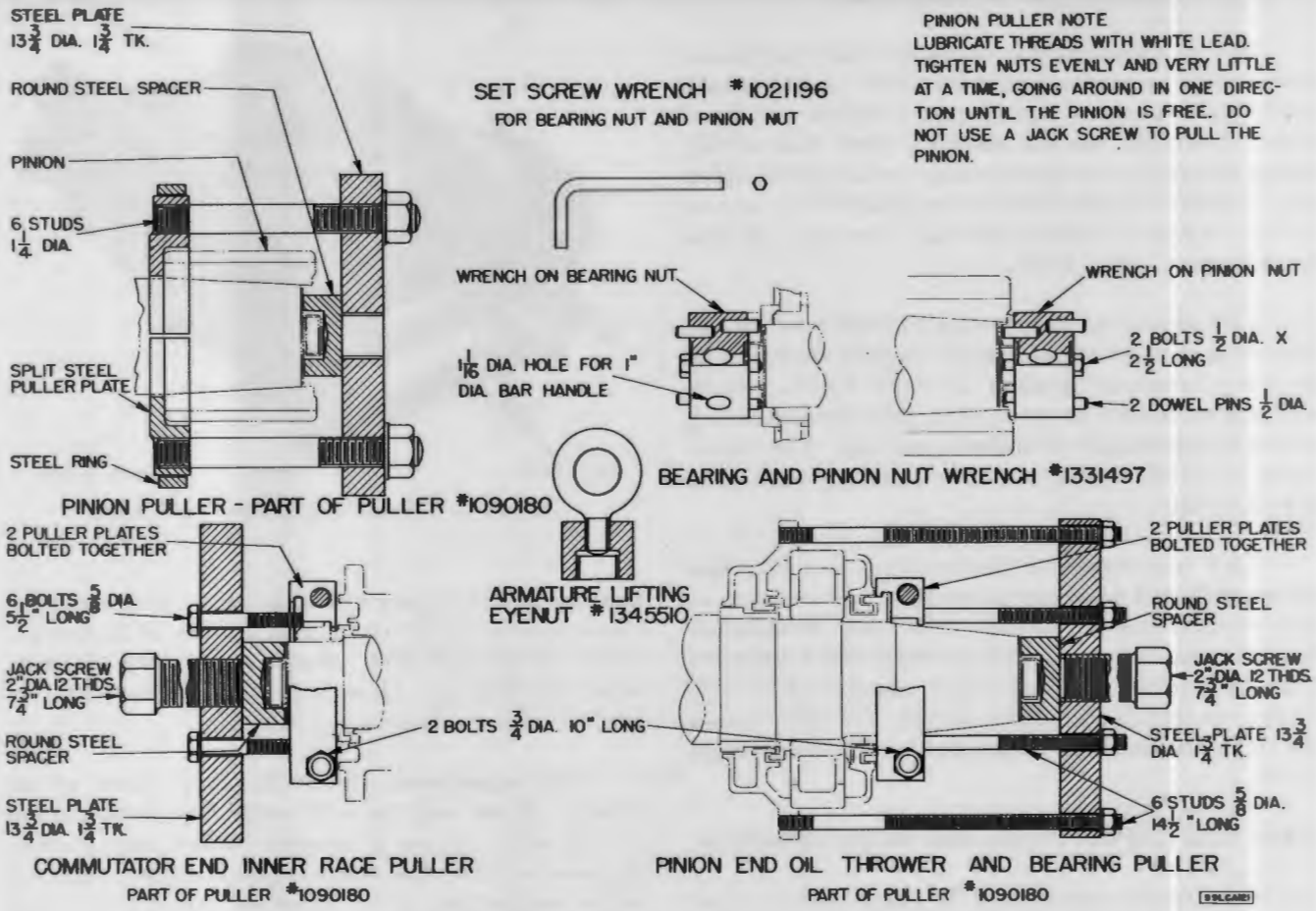
The apparatus should be kept clean at all times. Blow out the unit with dry compressed air at least once a month. When using compressed air for cleaning in the vicinity of exposed mica insulation, care must be taken not to use too high pressure or get the nozzle too close to the mica. If this practice is not followed, small flakes of mica will be blown off, finally resulting in the complete destruction of the insulation.

Oil is very destructive to insulating materials as it collects dust and dirt, causing the insulation to break down electrically. If any oil should get on any insulated parts, it should be thoroughly wiped off with a clean cloth. Remove any accumulation of oil and dirt, using compressed air and a petroleum solvent of the safety type. If the deposit is easily accessible, the solvent may be applied with a cloth, assisted by a stiff brush or wooden scraper. Care should be taken so that the petroleum solvent does not get on the commutator or other copper parts. The motor should not be sprayed with a cleaning liquid of any kind, as this will destroy the protective coating on the coils and leads.

Maintenance instructions for the heavier repairs are covered in the articles following, under the titles of the various parts.

## TO REMOVE TRACTION MOTOR FROM TRUCK

1. Remove the two bolts securing the gear




Illus. 2. Tool Assembly

case to the motor frame. Pull the gear case clips; the lower half of the gear case will drop down, and the upper half may be lifted off the frame.

2. Unbolt and remove the axle shield.

3. Unbolt the two motor axle caps, and remove the caps and the outer bearing halves.

4. Unbolt and remove the nose suspension safety bar, and remove the two nose suspension pins. Compress the springs by means of two clamping bolts. Lift the traction motor slightly, and slide out the nose suspension assembly.

5. Lift the motor out of the truck with a crane, hooking the lifting chains into the lugs on the motor frame. If three chains are employed, their lengths should be adjusted so that the motor will be lifted first on the side next to the truck center and rotated around the axle a sufficient amount so that the lower lip of the axle bearing housing will clear the axle before the slack in the chain attached to the axle side of the motor is taken up. The inner halves of the axle bearings may be blocked so that they remain with the motor when it is lifted off the axle. Also, the air duct assembly should be lifted out as the traction motor clears the truck frame.

## TO DISASSEMBLE THE TRACTION MOTOR

1. Loosen the pinion nut setscrews with the special wrench (Westinghouse No. 1021196); remove the pinion nut with the special wrench (Westinghouse No. 1331497); and remove the pinion with the special puller (Westinghouse No. 1090180). See Illus. 2. The use of heat, wedges, or a hammer should be avoided when removing a pinion. A hydraulic pinion puller may be used, if one is available. If the free roller bearing is not to be removed, or if the armature is not to be set on a lathe, the pinion need not be pulled from the armature shaft.

2. Remove the commutator covers, and remove all of the brushes. If the brushes are in good condition, mark them so that they may be later returned to their original locations.

3. Wrap heavy paper around the commutator surface to protect it when the armature is removed from the frame.

4. Unbolt and remove the commutator end outer bearing cap.

5. Using the special wrenches, loosen the bearing nut setscrews, and remove the bearing nut and the bearing thrust collar.

6. Cover the bearing with paper to keep it free of dirt.

7. Set the motor up on end, commutator end down, and remove the six pinion end housing bolts.

8. Screw the armature lifting eyenut (Westinghouse No. 1345510) onto the armature shaft. Attach a hoist and take up the slack.

9. Loosen the pinion end housing from its fit by screwing bolts into the tapped holes next to the through bolt holes.

10. Lift the armature, together with the pinion end housing, straight up out of the motor frame. Guide studs may be screwed into the commutator end inner bearing cap holes, to prevent the commutator from striking the brush holder during the removal of the armature. Set the armature on a suitable support with the shaft horizontal.

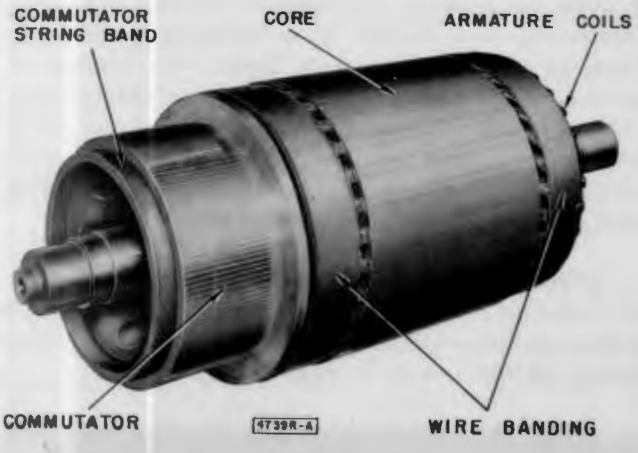
## ARMATURE

The armature consists mainly of a core of laminated metal wave wound with copper conductors. The conductors are connected to the segments of the commutator and are held in place by micarta wedges and wire bands. See Illus. 3.

For the removal of the armature see the previous article.

### General Maintenance

Whenever the motor is disassembled, the armature should be closely inspected for the condition of the bands, wedges, coils, commutator, and insulation. The slot wedges should be tight and all insulation should be free from flakes, cracks, or blisters. The servicing of the more important parts of the armature will be discussed individually in the articles following. Use the procedure given below when the condition of the armature is such that it requires dipping and baking. This will usually be determined by the period of use of the motor, or the failure of the armature to give satisfactory results during a megger and high potential ground test (See "Dipping and Baking").




Illus. 3. Armature Assembly

### Dipping and Baking

1. It is very important that the armature be thoroughly cleaned before it is dipped and baked. Unless all conducting dirt and grease is removed, the varnish treatment will not be fully effective.

Using clean dry air, blow the dirt from the surface and blow out the vent ducts from both ends of the armature. Remove as much of the oil, grease, and dirt from the apparatus as possible, with clean dry cloths. The windings should then be wiped using clean cloths moistened with a solvent such as Westinghouse No. 1609-2, Stoddard Compound, Varsol, or Sunoco Spirits. If the original varnish on the windings is cracked, use a brush wet with solvent to clean all conducting particles from the cracks. Use a swab moistened with the solvent to clean surfaces which cannot be reached by hand.

Using a pressure spray gun, clean under the commutator and through the vent holes with the armature in a vertical position, commutator end up. Repeat the spraying with the opposite end up. Finally, repeat the spraying with the commutator end up. The use of excessive amounts of solvent should be avoided to prevent any softening effect of the solvent on the varnish. The cleaning process should be completed by drying all of the cleaned parts with clean cloths.

2. Dry the armature in an oven at a temperature of 125° C. to 135° C. for six to eight hours.

3. After the drying, cool the armature to within 10° C. above room temperature, but never to less than 25° C. If the armature is placed in the varnish at a higher temperature, the varnish will tend to cure in the tank. On the other hand, if the armature is cooled to room temperature and allowed to stand, it will quickly take up moisture.

4. When the armature is cooled to the proper temperature as described above, dip it in the

varnish, commutator end up. Bring the varnish up to the back of the commutator neck and hold it for approximately 20 minutes.

Westinghouse Varnish No. 8826-1 should be used at a viscosity of not over 70 Seconds and not less than 20 Seconds, as measured at 25° C. with a Westinghouse Demmler Viscosity Cup No. 1. The varnish can be thinned with Westinghouse Solvent No. 1609-2 or benzine, and it should be kept clean by straining through a standard filter or a strong close-weave cotton cloth from time to time. The varnish should be held at a temperature of from 25° C. to 32° C. A higher temperature will cause the tank life to decrease, while a lower temperature will not give the best possible finish.

5. When the dipping is completed, remove the armature from the varnish and drain it with the commutator end up for about 1/2 hour. Wipe the varnish from the shaft, using a cloth soaked in the solvent.

6. Bake the armature, commutator end up, in a forced draft oven at a temperature of from 130° C. to 135° C. The baking time should be approximately eight hours, depending upon the type of oven used.

7. Dip the armature again as described in step four (4).

8. Bake the armature as described in step six (6), for approximately 24 hours.

9. Check the insulation resistance by means of a megger test. If the insulation resistance measures not less than five megohms, apply a high potential ground test using 1500 volts.

## COMMUTATOR

The commutator consists of a ring of copper segments insulated from each other by strips of mica. See Illus. 3.

### General Maintenance

Do not use any lubricant on the commutator, since there is a sufficient quantity of graphite in the brushes to supply all the lubrication required. If any oil should get on the commutator, it should be thoroughly wiped off with a clean cloth.

The commutator should present a smooth surface, free from pitting. If it has been excessively pitted or damaged from any cause, it may require grinding, and possibly even turning. When a commutator has been subjected to very heavy surge currents caused by flashovers, burned spots may appear on the surface. Since such spots cause a brush to momentarily leave the commutator surface, the spots may get progressively worse. Likewise, any eccentricity of a portion of the commutator surface may cause these abrasive burned spots. Whenever such spots appear, it may be necessary to smooth the surface and restore the concentricity by grinding the commutator.

By touching a brush with an insulating stick while the motor is running, it is possible to judge from the severity of vibration whether there is eccentricity. A more exact way, however, is to clamp a dial gauge on the frame to measure, in thousandths of an inch, the variation of the commutator radius as the armature is rotated by hand one commutator segment at a time. An eccentricity of 0.001 inch in less than brush spacing around the commutator may indicate the necessity of grinding. When the commutator has been badly burned or is extremely eccentric, it may be necessary to turn the commutator on a lathe.

### Grinding

Obtain a grinding rig (Westinghouse No. 1407886) and two grinding stones (Westinghouse No. 1407887) and clamp the rig firmly to the frame of the motor. The grinding stones should have two directions of feed. Care should be taken to make sure that the radial pressure of the stones on the turning commutator cannot readily deflect the rig. Remove all brushes from the brush holders. The commutator should be wiped clean of all oil or dirt before grinding. A hose from a suction fan should be attached to the commutator grinder to collect the copper dust. The traction motor blower motor should be made inoperative so that the cooling air will not draw copper dust into the traction motor.

Operate the motor at slow speed. This may be done by jacking the wheels off the rails and connecting the motor to a welding generator. When grinding, extremely light cuts should be taken at first, until the commutator approaches a true condition. Heavy cuts tend to cause some deflection of the rig and, therefore, the commutator may not reach true concentricity. The final cut should be made with fine stones.

Check the trued commutator with an accurate dial indicator. A variation of greater than 0.0015 inch in one revolution of the commutator may indicate the necessity of regrinding.

After the commutator has been ground, and especially if it had been turned first, the mica between the commutator segments may have to

be undercut. This is determined by an inspection of the depth of the mica all around the commutator. Special rotating saws are available for undercutting the mica. The slots should be cut to a depth of from a minimum of 3/64 inch to a maximum of 5/64 inch, and care must be taken not to cut the slots wider than the mica.

Whether or not the mica was undercut, the sharp edges of the commutator segments should be removed with a hand scraper or a knife. The edges of the segments should be given a slight bevel. Clean out the slots to remove all mica chips and fins, and make sure that no copper chips remain in the slots. A satisfactory tool for this operation can be made from a piece of worn out hack saw blade. The final polishing of the commutator should be done with a piece of No. 00 sandpaper. Complete the cleaning of the commutator by blowing it with dry air.

Turning

Remove the armature from the motor as described previously, and remove the bearing assemblies as explained in one of the articles following. Place the armature between the centers of a lathe, making sure that the bearing fits run true.

Before turning the commutator, make a suitable covering to keep the chips from falling into the armature. Use a strip of cloth wide enough to cover the commutator risers and wire banding and long enough to encircle the armature. Wrap an edge of this cloth around the commutator risers and bind with a cord. Then turn the cloth up over the cord and bind with another cord to the outside of the armature, covering the wire banding.

In turning the commutator remove only enough copper to give a uniform surface. Use a carboloy side-cutting tool with the point ground to about 1/16 inch radius. The cutting side of the point should be given more rake than is customary for working iron and steel. The tool should be sharp enough to make a clean, smooth cut without dragging over the mica. The commutator should be cut at a surface speed of about 300 feet per minute with a carboloy tool.

After the commutator is turned and the armature still on the lathe, round off the ends of the commutator segments with a file to at least 1/16 inch radius. Bring the commutator to its final concentricity by means of a fine grinding stone.

The remainder of the turning procedure is the same as that for grinding, beginning with the checking of the trued commutator under "Grinding".

## COMMUTATOR STRING BAND

This band consists of a layer of Westinghouse No. 2444-2 cord which is wound over the mica V-ring by hand. See Illus. 3.

Maintenance

Wipe all dirt and grease off the string band, and be certain that it is tight and has a smooth surface. If the finish has started to flake or chip, sand it lightly and blow it with dry compressed air. Several coats of red enamel similar to Westinghouse No. 7340-1 should then be applied and permitted to dry. If the string is broken, it should be replaced.

## ARMATURE COILS

Each armature coil consists of five insulated turns which are bound together with treated glass tape. The coil leads are soldered to the commutator risers, and the coils held in place by micarta wedges, which are driven into the core slots over the coil sides. See Illus. 3.

Maintenance

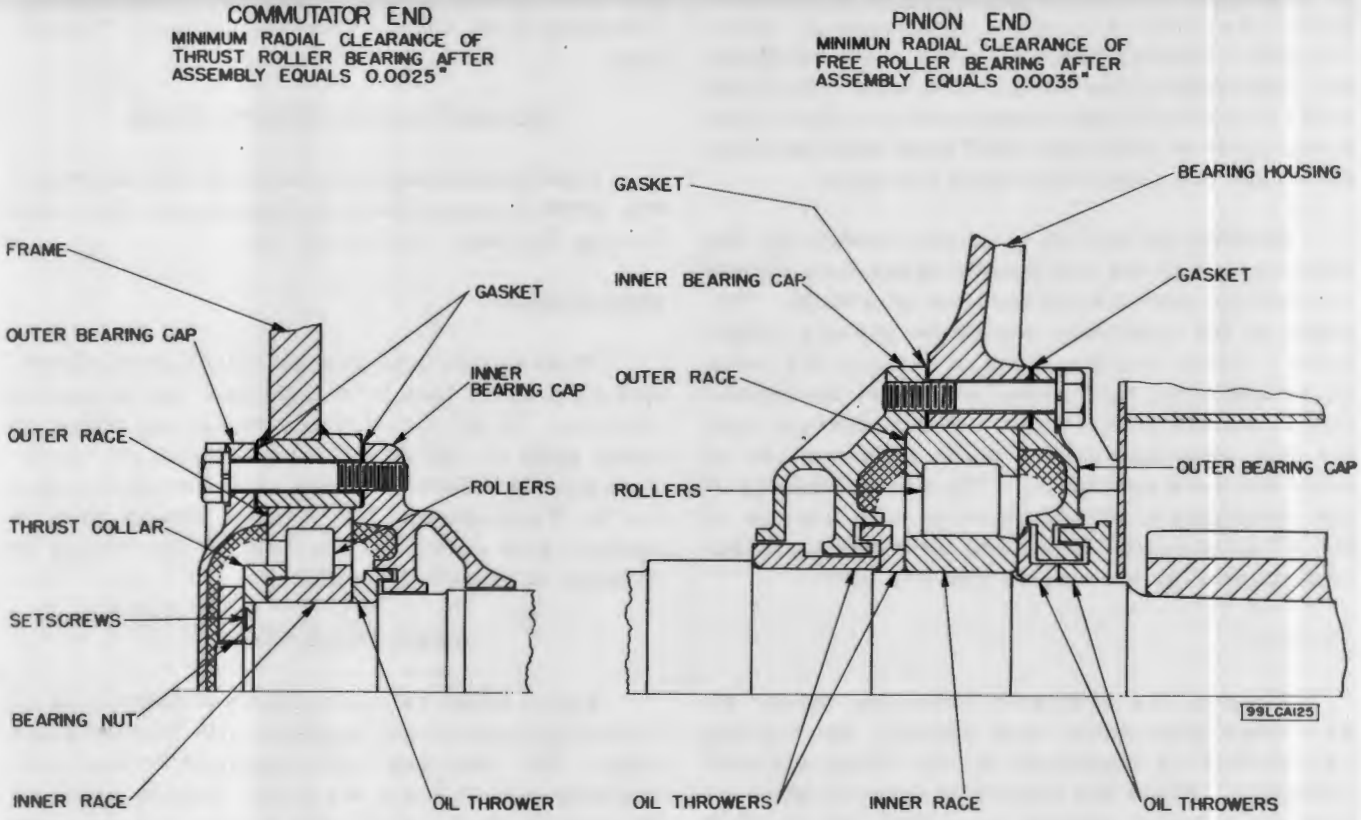
The armature coils, due to their nature and position will not generally be serviced in the field. Should a short occur between conductors in a coil, it would be necessary to replace the coil. This would involve removing the banding and micarta wedges, unsoldering the leads from the commutator risers, replacing the coils, reassembling the armature, dipping and baking, and rebalancing the armature, all of which should preferably be done in the manufacturer's shop. If the solder holding the coil leads in the commutator risers should ever be thrown out and the armature is not otherwise disturbed so as to require rewinding, the leads should be resoldered with Westinghouse No. 9344-1 high temperature solder.

## BANDING

The two armature bands consist of nonmagnetic wire tightly wound around the coil extensions to hold them in place. See Illus. 3.

Maintenance

Whenever the armature is removed, the condition of the banding should be noted. If there




Illus. 4. Bearing Assemblies

appears to be any shifting or separation of the wires due to loss of solder, the band should be replaced and the armature rebalanced. This should preferably be done by the manufacturer.

## BEARING ASSEMBLIES

The commutator end bearing assembly consists of the bearing housing, thrust roller bearing, oil thrower, inner and outer bearing caps, and bearing cap gaskets. See Illus. 4.

The pinion end bearing assembly consists of the bearing housing, free roller bearing, four oil throwers, inner and outer bearing caps, and bearing cap gasket. See Illus. 4.

### Maintenance

The servicing required for all of the bearing assembly parts except the roller bearings, will consist of cleaning with kerosene or a similar solvent to remove the accumulation of old and hardened grease. If grease leakage is occurring, the bearing cap gaskets may need replacing.

## TO REMOVE THE BEARING ASSEMBLIES

1. Remove the armature from the traction motor stator as explained in the article entitled, "TO DISASSEMBLE THE TRACTION MOTOR".
2. Using the special puller (Westinghouse No. 1090180), remove the commutator end inner race, and then the oil thrower and inner bearing cap. See Illus. 2.
3. Remove the pinion end outer oil thrower with the puller, as shown in Illus. 2.
4. Unbolt and remove the pinion end outer bearing cap, and lift off the bearing housing.
5. Remove the pinion end inner bearing cap, oil throwers, and roller bearing with the puller, as shown in Illus. 2.
6. The outer race and roller portion of the commutator end bearing assembly may be pressed out of its bearing housing.

## ROLLER BEARINGS

The thrust roller bearing and free roller bearing bear the weight and thrust of the armature and at the same time allow armature rotation with a minimum of friction.

Cleaning

If a regular tank or booth is not available, the bearing parts may be cleaned in an open container filled with kerosene or some other safety type solvent. Carbon tetrachloride, benzine, and gasoline are not recommended because of their extreme drying action. The container should preferably have a screen false bottom to minimize the circulation of dirt and old grease. The cleaning solution should be changed frequently and the container thoroughly cleaned.

A soft brush may be employed to remove the accumulation of old grease, and the rollers should be rotated while submerged in the solvent. After all dirt and grease have been removed, the bearing parts may be dipped in plain water to remove all traces of the solvent. The plain water dip should not be attempted unless equipment is available, such as an oven or hot plate, to ensure that any retained moisture is thoroughly removed.

After the inspection of the bearings is completed as explained below, they should be completely dried with clean, dry compressed air. If the bearings are to be put into immediate service, they should be dipped in a warm mineral lubricating oil of SAE-10 grade to prevent corrosion of the highly polished surfaces. If the bearings are to be stored, they should be dipped in a slushing compound of warm petroleum jelly. In either case, a suitable protective wrapping should be immediately applied.

Inspection

After the bearings have been cleaned and dried, the outer races should be inspected. Observe the surface at the outer diameter of the outer race. If there is evidence of spinning, the fit should be carefully checked. If the race is undersize, the bearing should be discarded. In the case of the roller bearing, where the inner surface of the outer race cannot be seen, a flaked race will usually cause the rollers to be dented. Grasping a roller and sliding it along the race provides a further test to establish flaking.

Inspect the rollers. Examine them visually to determine if metal has flaked from the surface. If flaking has occurred, remove the bearing from service. A small amount of evenly distributed denting marks on the rollers is not considered serious. Several concentrated denting marks is serious enough to reject the bearing for further service. Examine the cages for wear. In the roller bearing, excessive wear will usually cause small knife-edge lips to be turned up on the bronze retainer adjacent to the rollers. Examine the ends of the rollers for smearing, which is a condition caused by lack of lubrication between the roller ends and the flange. If a bad condition of smearing exists, remove the bearing from service.

Inspect the inner races. Examine the roller path to see that it is smooth and free from breaks. Dirt denting is not considered serious if it is not concentrated. Examine the bore of the inner race. If there is evidence of turning on the shaft, the bearing should be replaced.

Another important step in the inspection of the bearing is to rotate the assembled bearing and feel for smoothness of operation. This should not be done until after the bearing is lubricated. The internal radial clearance of both bearings should be checked by passing (not rolling) a feeler gauge between the rollers and the inner race. The clearances should be 0.0049 to 0.0071 inch for the pinion end bearing and 0.0039 to 0.0055 inch for the commutator end bearing.

Repacking

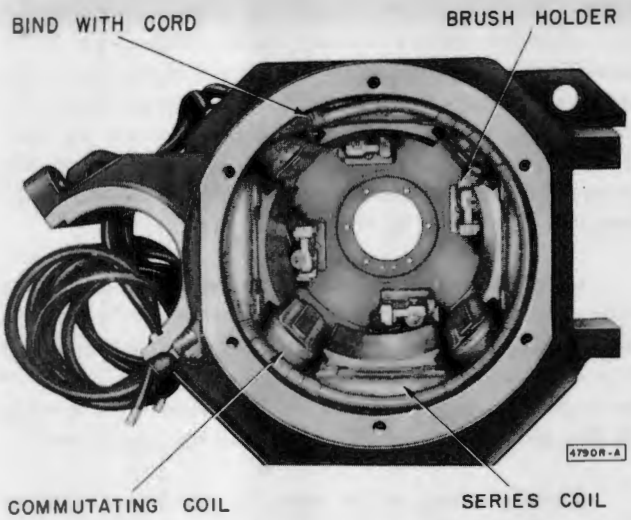
When the bearings are reassembled, they should be repacked. To properly lubricate a bearing all of the space between the rollers, and the internal cavities about the retainer, should be completely filled with grease. The lower half only of the inner and outer bearing caps should be packed with sufficient grease to come in contact with the bearings when completely assembled. Do not use too much grease, since this causes the bearings to overheat. The grease to be used is Westinghouse PD No. 8750-1.

## TO REPLACE THE BEARING ASSEMBLIES

1. Heat the oil throwers and both inner races in an oil bath for shrinking onto the shaft. SAE-40 oil may be used for heating. The parts should be left in the oil for at least 1-1/2 hours to insure complete expansion. The oil throwers should be heated to about 150° C. and the inner races to from 100° C. to 125° C.

2. Wipe both ends of the armature shaft free of all dirt and grease, and slide both inner bearing caps into position on the shaft.

3. When removing the parts from the hot oil, it is best to first pick them out with a wire and wipe off the excess oil. Should any of the parts stick, they may be tapped lightly using a copper or brass bar and a hammer, but should




Illus. 5. Field Assembly

not be driven on the shaft with great force. All labyrinths should be sealed with Westinghouse PD No. 2694 grease during assembly.

4. Slide the heated inner oil throwers and inner races firmly into their correct positions on either side of the armature shaft, using clean gloves. See Illus. 4.

5. When the pinion end inner race has cooled, assemble the outer race and rollers into the bearing housing, and slide the assembly, with a gasket, over the inner race. The bearing and caps should first be packed with grease, as described in the article on "Repacking".

6. Bolt the pinion end outer bearing cap, with gasket, into place temporarily.

7. Press the commutator end outer race and roller portion of the bearing into its housing, and pack the rollers and caps with grease.

8. Cover all bearing assembly parts with paper to keep them dust-free.

9. The remainder of the bearing assembly parts are assembled when the armature is replaced in the motor frame, as explained in the article entitled, "TO ASSEMBLE THE TRACTION MOTOR".

## FIELD ASSEMBLY

The field assembly consists of the traction motor frame; four series field pole and coil assemblies; four commutating field pole and coil assemblies; and the coil sleeve connectors, along with the traction motor leads. See Illus. 5.

### General Maintenance

The coil insulation should be inspected to see that it is clean and free from flakes, cracks, or blisters. If a field coil burns out, it should be replaced. All cables should be tightly secured, and the insulation in good condition. Any defective parts should be replaced. Use the procedure given below when the condition of the coils is such that they require spraying and baking. This will usually be determined by the period of use of the motor, or the failure of the coils to give satisfactory results during a megger and high potential ground test (See "Spraying and Baking").

### Spraying and Baking

1. It is very important that the stator be thoroughly cleaned before it is sprayed and baked. Unless all conducting dirt and grease is removed, the varnish treatment will not be fully effective.

Using clean dry air, blow the dirt from the surface of the field coils, poles, and frame. Remove as much of the oil, grease, and dirt from the apparatus as possible, with clean dry cloths. The coils should then be wiped using clean cloths moistened with a solvent such as Westinghouse No. 1609-2, Stoddard Compound, Varsol, or Sunoco Spirits. If the original varnish on the coils is cracked, use a brush wet with solvent to clean all conducting particles from the cracks. Use a swab moistened with the solvent to clean surfaces which cannot be reached by hand.

The use of excessive amounts of solvent should be avoided to prevent any softening effect of the solvent on the varnish. The cleaning process should be completed by drying all of the cleaned parts with clean cloths.

2. Heat the stator in an oven to a temperature of 135° C.

3. Spray the stator while hot with Westinghouse No. 8826-2 Varnish at a viscosity of 110 to 135 Seconds, as measured at 25° C. with a Westinghouse Demmler Viscosity Cup No. 1.

4. Bake the stator in a forced draft oven at 135° C. for about four hours, depending upon the type of oven used.

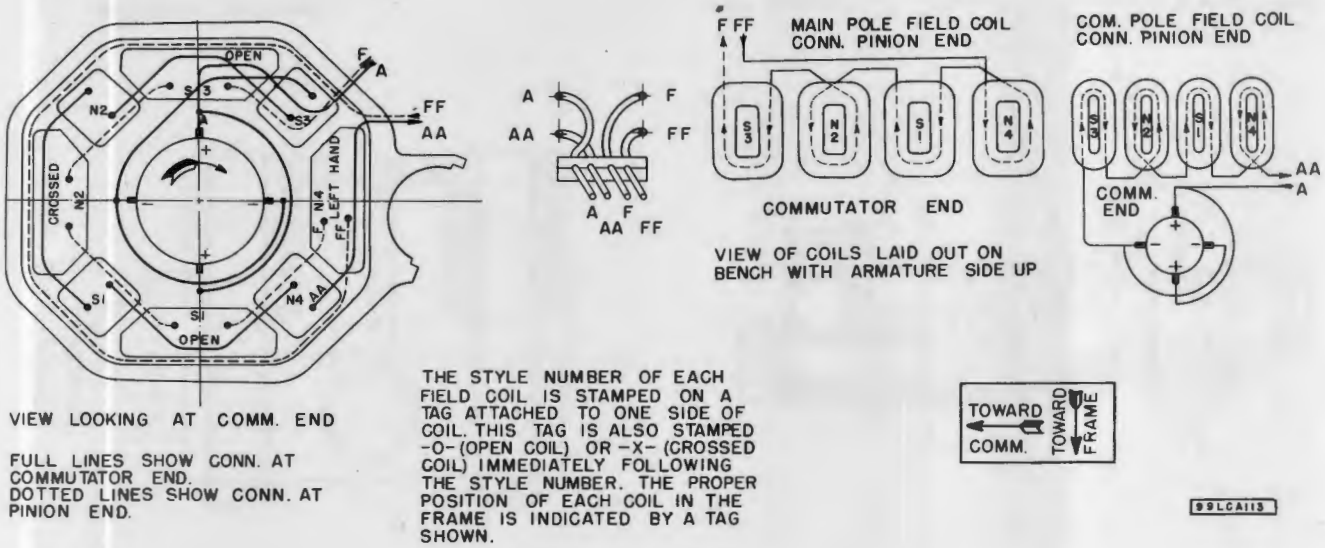
5. Spray the stator with a second coat of No. 8826-2 varnish.

6. Bake the stator again at 135° C. for about four hours.

7. Spray the stator with a third coat of No. 8826-2 varnish.

8. Bake the stator for the final time at 135° C. for about six hours.

9. After the final baking, spray the stator with one coat of Westinghouse No. 7340-1 red




Illus. 6. Wiring Diagram

enamel and air dry.

10. Check the insulation resistance by means of a megger test. If the insulation resistance measures not less than five megohms, apply a high potential ground test using 1500 volts.

The treatment described above may be used in part only, as indicated by the condition of the particular apparatus involved. It is also permissable to treat the field assembly by dipping and baking it three times as explained under "Dipping and Baking" of the armature. The frame fit surfaces should be painted with a masking compound and the bolt holes plugged with the proper size bolt. This latter method eliminates the difficulty of applying the spray through the close clearance between the field coils.

## TO DISASSEMBLE THE FIELD ASSEMBLY

In the following discussion it is assumed that the traction motor has been disassembled as described in a previous article.

1. Mark all coils, pole pieces, washers, and springs, so that they may be replaced in their original position when reassembling.

2. Disconnect all coil leads.

3. Lay the motor frame on its side so that it may be rolled over conveniently into different positions.

4. Remove the bolts holding each of the commutating pole and coil assemblies, and lift the assemblies out of the frame.

5. Remove the series pole and coil assemblies in the same manner.

If only one series field coil is to be removed, first unbolt and remove its pole piece. Then unbolt and remove an adjacent commutating pole and coil assembly, to provide sufficient room for the removal of the series field coil.

## TO ASSEMBLE THE FIELD ASSEMBLY

The procedure for assembling the field is the reverse of that used to disassemble the field, with the exception of the items listed below.

1. Make sure that the pole seats are clean.

2. Use new lockwashers, and pull the poles firmly to their seats with the bolts.

3. After the coils are properly connected (See Illus. 6), their relative polarity can be checked by exciting the field circuit with about five amperes of direct current. Using a compass, check to see that adjacent poles of the same field circuit are of opposite polarity.

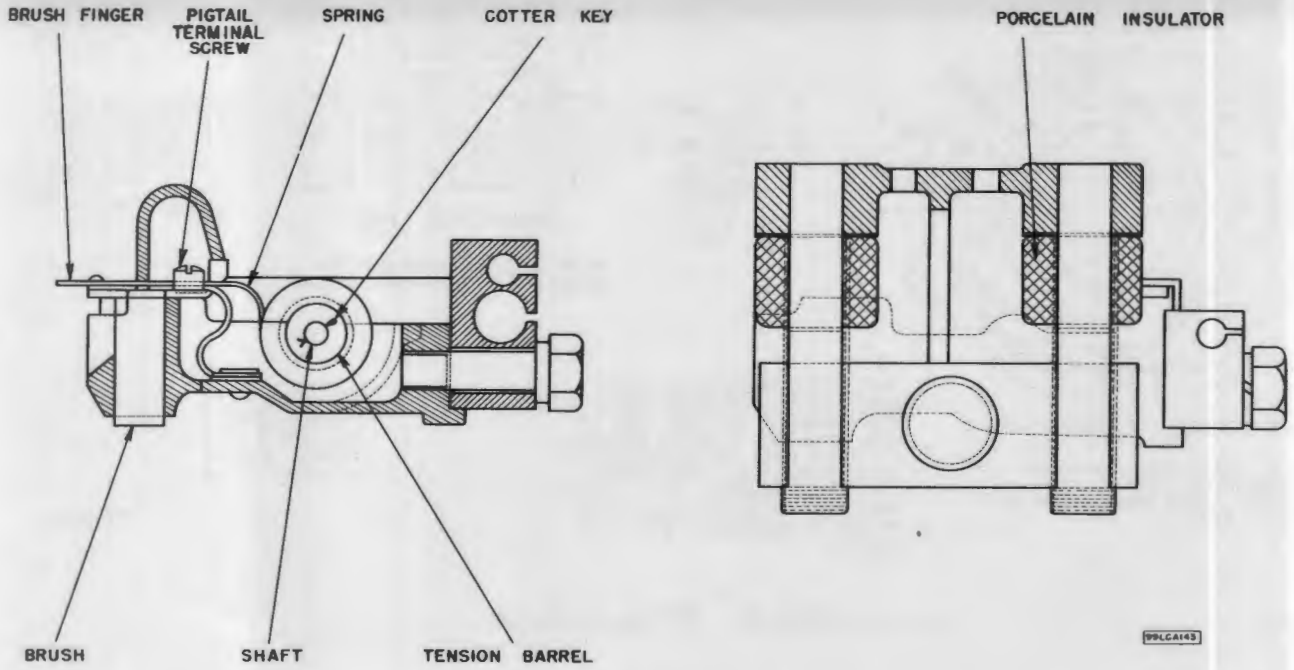
4. Make a voltage drop test of each field coil, using about 50 per cent of full field current.

5. Make a megger test connecting the two field windings together. The insulation resistance should measure at least one megohm.

6. Make a high potential ground test between the coils and the frame using 1500 volts.

7. Wrap all coil sleeve connectors with insulation tape, and bind all loosely held cables with fibreglas cord.

8. Give the assembled field one coat of Westinghouse No. 7340-1 air drying red enamel.




Illus. 7. Brush Holder Assembly

## BRUSH HOLDER ASSEMBLY

The complete brush holder assembly is shown in Illus. 7. See the data sheet for descriptive information on the brushes.

### General Maintenance

The brushes should slide freely in their holders. Work the brushes up and down several times to release any carbon dust or other foreign material which tends to cause binding. Brush thickness (not width) is very important, the clearance of a new brush in a new holder being 0.003 to 0.010 inch. When working with brushes do not snap the brush fingers, as this may chip the brushes.

The pigtails on the brushes should be fastened securely under the terminal screws on the brush holder castings. Wipe the brush holder porcelain insulators clean of all oil or dust, with a clean cloth. If the insulators should become cracked or worn, they should be replaced. The pressure of the brushes should be checked at least once a month, as described in an article following.

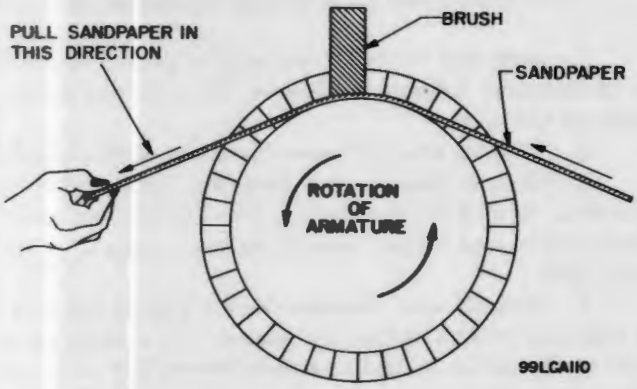
Wear on a brush reduces its length and, consequently, the spring tension. The brush length should be checked at least once a month, and brushes which have been worn beyond the minimum stated on the data sheet, or have been chipped, should be replaced with the same grade of brush. This is necessary since widely different kinds of brushes on the same motor may affect the operation.

### Replacing Brushes

To replace a brush, first reach through the commutator end housing and unscrew the terminal screw which holds the pigtail. Lift the brush finger from the brush, and remove the brush. Clean the brush slot of any grit or carbon dust, and insert a new brush. Release the brush finger carefully, not allowing it to strike and chip the brush. Attach the free end of the pigtail to the brush holder terminal screw. The new brush will have to be sanded as explained in the article following.

### Sanding Brushes

When new brushes are installed, they should be fitted to the commutator by sandpapering, as shown in Illus. 8. In fitting a brush a piece of fine sandpaper is inserted between the brush and the commutator, with the rough side of the sandpaper against the brush. The sandpaper is drawn in the direction of rotation, keeping the paper close to the commutator to avoid rounding the edges of the brush. After each stroke with the sandpaper, the brush should be lifted and the paper moved back for the next stroke. This should be repeated until the brush has the same




Illus. 8. Sanding Brushes

curvature as the commutator. A complete set of brushes may be fitted by wrapping a long piece of sandpaper around the commutator. The sandpaper should be secured so that it rotates with the commutator as the armature is turned in the proper direction.

### Checking Brush Pressure

Proper brush pressure should be maintained, as unequal brush pressure will cause unequal current distribution in the brushes. The brush pressure may be determined by inserting a piece of paper between the brush and the commutator and lifting the brush finger with a spring balance, as shown in Illus. 9. When the paper slips while subjected to a slight pull, the scale will indicate the brush pressure. See the data sheet for the correct brush pressure.

Should it be necessary to readjust the brush pressure, this can be done by first withdrawing the cotter key that holds the tension barrel which holds each spring. The tension barrel may be turned by inserting a 1/8 inch diameter pin in one of the holes and turning the barrel until the spring tension is the amount specified on the data sheet. Then line up one of the holes in the barrel with a hole in the shaft and insert the cotter key. See Illus. 7.

### Brush Holder Removal

When a brush holder must be removed for replacement or for adjustment, this is accomplished by first lifting the brushes from the commutator and clamping them in this position with the brush fingers. Remove the bolt holding the brush holder cable connector to the brush holder casting. The bolt passing through the brush holder inner mounting block and into the outer mounting block should then be removed, and the brush holder lifted from the commutator end housing.

### Brush Holder Clearance and Replacement

The proper clearance must be maintained between the bottom of the brush holder and the commutator surface. The brush holder must, therefore, be kept rigidly bolted in position. This clearance should be 1/8 to 3/16 inch. When the brush holder is to be replaced, a piece of flexible material (such as cardboard) as thick as the specified clearance is placed over the commutator to provide the proper spacing between the brush holder and the commutator. When the brush holder is firm against the spacer, the mounting block bolt may be tightened. The flexible spacer may then be removed and the brushes returned to their running position. The brush holder cable connector should then be refastened to the brush holder casting.

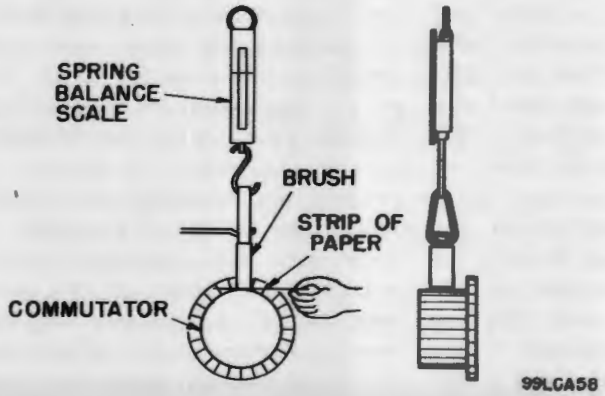
## AXLE BEARINGS

The axle bearings consist of four 8-1/4 inch bore bronze bearing halves which are held in the traction motor frame by two bearing caps. See Illus. 10. The bearings are oil lubricated and waste packed.

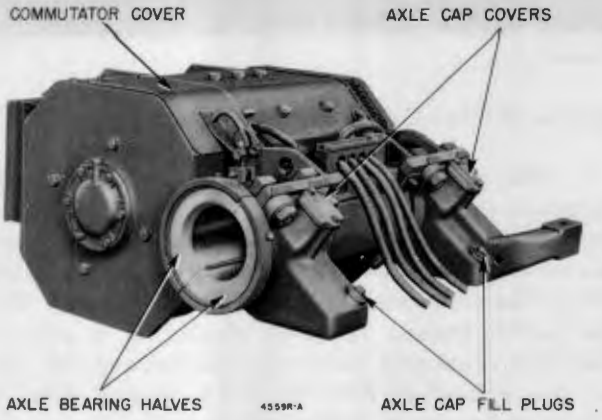
### Maintenance

New axle bearings are bored 0.028 to 0.030 inch larger than the axle over the center portion and 0.046 to 0.050 inch larger than the axle near the ends, to give a relief bore. The axle bearing seats in the motor are bored to size with a 0.017 inch shim between the caps and the frame to give a clamping fit.

Wear in the axle bearings is not as serious as wear in the armature bearings, but it is good




Illus. 9. Checking Brush Pressure




Illus. 10. Assembled Motor, Commutator End

practice to renew axle bearings that show wear of 1/8 inch maximum. The amount of clearance can be measured by inserting a narrow feeler gauge between the under side of the axle and the bearing, the gauging being accomplished by removing the axle shield. The end wear on each bearing should not be allowed to exceed a maximum of 1/4 inch on the commutator end, nor 3/32 inch on the pinion end. The axle shield and dust guard should be kept in place at all times when the locomotive is in operation, as dust and grit will work into the bearings, greatly increasing their wear.

Hot bearings may occur occasionally and are usually the result of one of the following causes:

1. Lack of oil in bearings.
2. Improperly packed bearings.
3. New bearings with insufficient clearance.
4. Grit or foreign substances working into the bearings.
5. Excessive end play in truck axles.

In case of trouble, immediately investigate the level of the oil in the well to make sure that it is up to the amount specified on the data sheet. Examine the waste packing and make sure that it has not fallen away from the shaft. If so, repack the bearings as explained in the article entitled, "TO REPACK THE AXLE BEARINGS". In the case of new axle bearings, it is well to examine the clearance, as bearings too tightly set up are frequently the cause of trouble. If the trouble persists with the bearings freshly packed, oil at the right level, and ample clearances, the bearings should be removed and examined. If the bearings show signs of cutting, they should be carefully scraped down to a new surface, or if too badly scored, they should be replaced with new bearings.

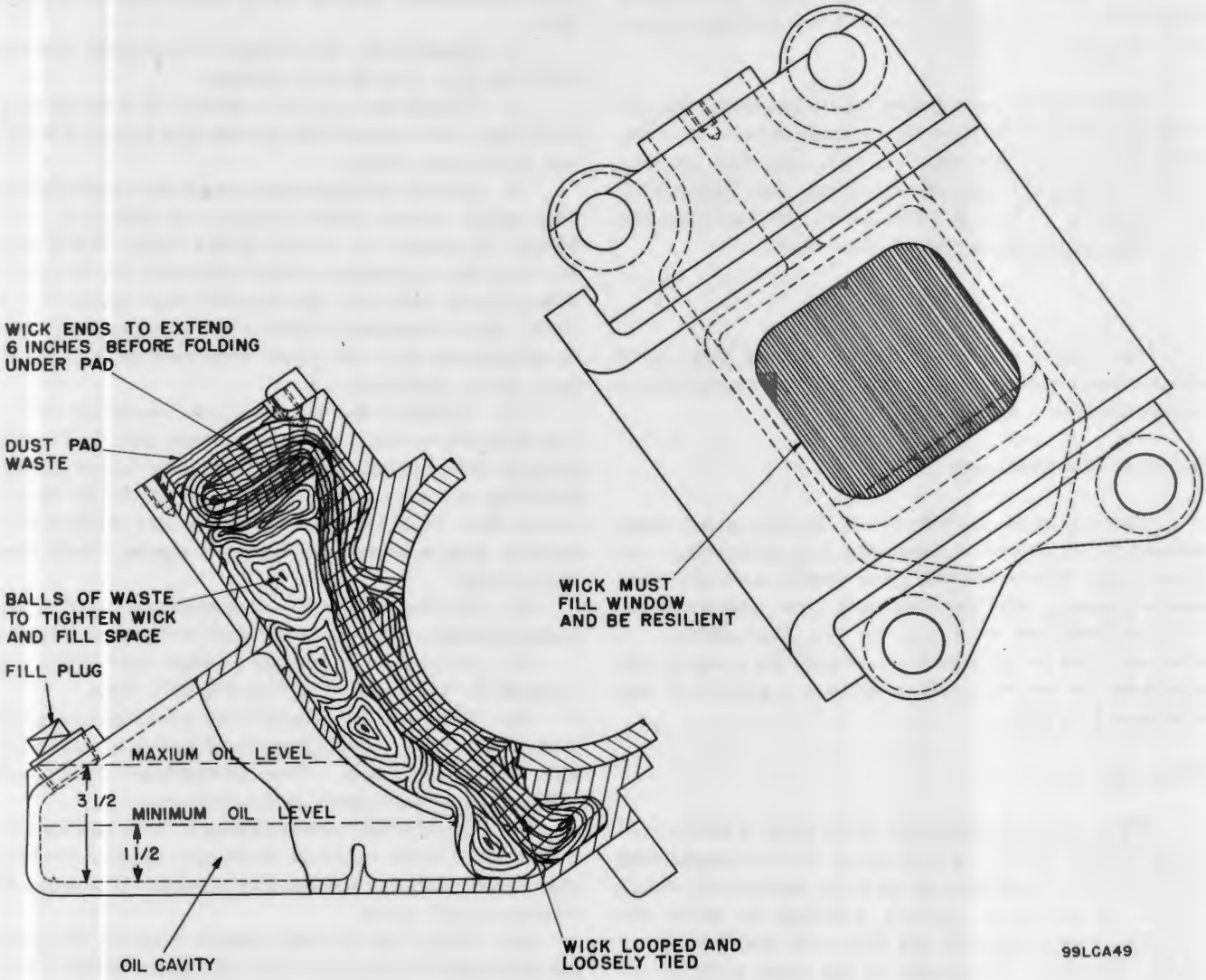
## TO REMOVE THE AXLE BEARINGS

1. Run the locomotive over a pit, or locate it to the best advantage for working on the under side of the axle.
2. Unbolt and remove the axle dust shield.
3. If the pinion end bearing is to be removed, it will be necessary to remove the gear case bolts and clips, and drop the lower half of the case.
4. Unbolt and remove the axle bearing cap. If the cap sticks it can be loosened by tapping a flat cold chisel in the crack between the cap and the motor frame, first on one side and then on the other. The lower half of the axle bearing will drop down with the axle bearing cap.
5. Using a wooden block and hammer, knock the lower axle bearing half out of the axle bearing cap.
6. To remove the upper half of the bearing, jack up under the motor frame a sufficient amount to relieve the weight on the bearing. Then revolve the bearing half around the axle until it can be slipped off below. If the bearing sticks in the frame, it can be knocked loose by driving down on the flange with a hammer and wooden block.

## TO REPLACE THE AXLE BEARINGS

The procedure for replacing the axle bearings is the reverse of that used to remove them, with the exception of the items listed below.

1. Before installing new bearings, make sure that they are perfectly clean, and rub a little oil over their surfaces. For new bearings, shims 0.010 to 0.012 inch thick should be inserted between the axle cap and the motor frame. The axle caps should be driven in straight, as rocking will distort the splines and pinch the bearings. The radial clearance in the axle bearings should be at least 0.015 inch. After the locomotive has been in service long enough to wear the bearings in (generally about 50,000 miles), the shims are removed.
2. Before replacing a bearing which has been cutting, examine the journal carefully. Remove any roughness with fine emery paper; wipe the journal with a clean rag; and then rub on a film of oil.
3. Grease should not be used on a journal which is lubricated by oil and waste, as the grease will glaze over the waste surface and prevent the oil from reaching the bearing.
4. When reassembling the old bearings, be sure to place the bearing halves in their original positions.
5. Repack the bearing caps with clean new




Illus. 11. Waste Packed Axle Bearing Cap

waste and fill the oil wells to the proper level, as described in the article following.

## TO REPACK THE AXLE BEARINGS

The axle caps must be packed before they are filled. The oil is drawn up from the oil well to the bearing by the capillary action in the strands of waste. Thus it is essential, for proper lubrication, to provide a continuous path for the oil flow. This means that long strand wool waste must be used, and the waste must be in actual contact with the journal. The axle caps should be flushed clean with kerosene before repacking.

Before using the waste, it should be saturated in oil for at least 24 hours and left on a grating to dry for several hours. Wicks are prepared by forming the oiled waste into skeins of sufficient length to reach from the bottom of the waste chamber up to about six inches above the waste chamber cover seat. See Illus. 11. When the skeins are packed, they should be twisted about one complete turn to hold all of the strands of yarn in place and produce a springy wick.

Three skeins should be packed into the waste chamber and held against the axle by means of a wide packing iron. The upper ends of the skeins should be allowed to hang out of the axle cap about six inches. The remainder of the chamber should then be filled with several balls of oiled waste, and the wide packing iron removed. The loose upper ends of the skeins should be folded over the other waste and tamped down tight. A pad of saturated waste large enough to fill the remainder of the waste chamber should be placed

on top of the wick to catch and hold dirt which might fall in whenever the waste chamber cover is removed.

After the bearing has been packed, the oil well should be filled to the proper level. See the data sheet for the type of oil, and the proper height of the oil measured from the bottom of the chamber. The oil should be poured into the oil well, and not on top of the waste.

## GEAR CASE

The upper and lower halves of the gear case are bolted together and supported by the traction motor frame. See Illus. 1.

### General Maintenance

The amount of lubricant in the gear case should be checked frequently by removing the pipe plug. Examine the gear teeth, and if bright spots appear, add the correct type and quantity of lubricant as stated on the data sheet. A summer grade of lubricant should be used if the weather is warm, and a winter grade if the weather is cold.

### Cleaning

When overhauling the gear case remove all oil and dirt either by scraping, or by immersing the case in a solution of caustic potash in which steam is injected. Never attempt to burn out the old grease and oil, as this will warp the gear case. Repaint the inside of the case with an oil resistant enamel. Examine the felt seals for wear or damage, and replace if necessary.

## TO ASSEMBLE THE TRACTION MOTOR

1. Place the motor frame in a vertical position, commutator end down.
2. Wrap the commutator with heavy paper for protection.
3. Hoist up the armature using the armature lifting eyenut, and carefully lower it into the motor frame. Guide studs may be screwed into the commutator end inner bearing cap holes to assist in seating the armature. The commutator end inner bearing cap gasket may be held in place with grease.
4. Screw the pinion end housing bolts into place evenly, but do not tighten. If the housing bolts are screwed in unevenly, the bearing assemblies will be tipped and the races damaged.
5. Check the commutator end bearing radial clearance by passing (not rolling) a feeler gauge between the rollers and inner race. The assembled clearance should be a minimum of 0.0025 inch.
6. Assemble the thrust collar and add the bearing nut, but do not tighten.
7. Place the traction motor in a horizontal position, and tighten the pinion end bearing housing bolts securely.
8. Check the squareness of the commutator end outer race with respect to the armature shaft. It should be within 0.001 inch. This may be done by clamping a dial indicator to the armature shaft with its tip against the outer race. Push the armature toward the commutator end to eliminate any end play, and rotate the armature while gauging.
9. Tighten the bearing nut securely using the special wrench (Westinghouse No. 1331497). Screw two setscrews in opposite holes in the bearing nut using the special wrench (Westinghouse No. 1021196). Tighten the setscrews, strike with a hammer, tighten again, and peen them over.
10. Assemble the commutator end outer bearing cap, with gasket, and bolt securely.
11. Measure the armature end play. It should be between 0.005 and 0.011 inch.
12. Remove the pinion end outer bearing cap and check the radial clearance between the rollers and inner race. The assembled clearance should be a minimum of 0.0035 inch.
13. Check the squareness of the pinion end outer race with respect to the armature shaft as was done with the commutator end. It should be within 0.002 inch.
14. Slide the heated pinion end oil thrower on the shaft firmly against the inner race. For further details see the article entitled, "TO REPLACE THE BEARING ASSEMBLIES".
15. Replace the pinion end outer bearing cap, with gasket, and bolt securely.
16. Slide the heated pinion end outer oil thrower firmly into place on the armature shaft.
17. Remove the commutator paper covering, and set the brush holder clearances as explained under "Brush Holder Clearance and Replacement". Also, return the brushes to their correct locations.
18. Shrink the pinion on the shaft as described in the article following.

## TO APPLY THE TRACTION MOTOR PINION

1. Inspect the shaft and the pinion bore to see that all burrs are removed. Inspect the pinion teeth for wear. Replace a pinion having 15 or less teeth, as soon as the tops of the teeth are worn to a knife edge. Replace a pinion having more than 15 teeth, as soon as the teeth are worn to a thickness of 1/8 inch, measured at the

tops of the teeth. The gear should be replaced when the teeth are worn to a thickness of 3/16 inch (measured at their tops). A pinion or gear which has any obvious defects, or which shows fatigue cracks at the roots of the teeth during a magnetic inspection, should be replaced.

2. The pinion fit on the shaft should be checked with Prussian Blue. To do this, first rub the Prussian Blue on the shaft. Then place the pinion on the shaft about one inch from its final position, and give the pinion a quick push to its final position. The pinion should be removed by driving a metal wedge between the pinion face and the outer oil thrower. A wedge should only be used to remove a pinion which has been applied on the shaft while cold.

3. Scrape or stone the pinion bore until at least 75 per cent of the area is in contact with the shaft. Then clean the pinion bore and the shaft with benzol, to remove all traces of oil and Prussian Blue.

4. With the pinion and the shaft at room temperature, place the pinion on the shaft about one inch from its final position, and give the pinion a quick push to its final position.

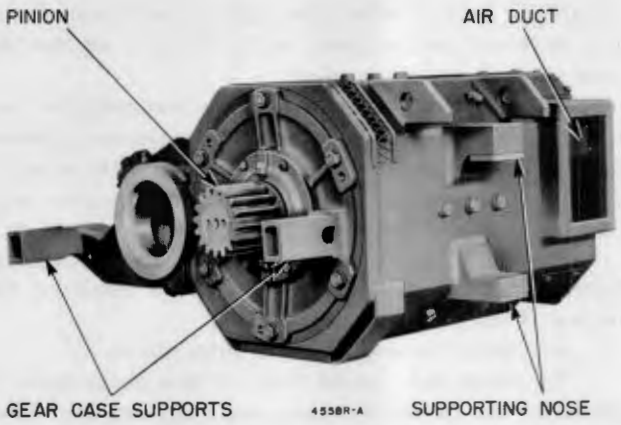
5. Measure the distance the pinion stands off from the end of the shaft by means of a depth gauge. The points of measurement should be marked on the pinion and the end of the shaft so that after heating the pinion, it can be mounted in exactly the same angular position on the shaft, and measurements made from the same points.

6. Remove the pinion from the shaft by driving a wedge between the pinion face and the outer oil thrower.

7. Heat the pinion uniformly and for a sufficient length of time to allow the heat to penetrate thoroughly. The application temperature should be 140° C. plus the temperature of the shaft, plus 10° to allow for heat lost while removing the pinion from the oven, cleaning the bore, and checking the temperature before applying. The pinion may be heated by means of an induction heater, electric oven, or gas oven. The pinion should never be heated above 200° C., nor should it ever be heated in oil.

8. Remove the pinion from the oven and place it near the shaft to which it is to be applied. Both the shaft and pinion bore should be cleaned very thoroughly with clean dry cloths to remove all traces of oil or other foreign matter.

9. Check the pinion temperature with an electric pyrometer as close to the pinion bore as possible. As soon as the pinion temperature comes down to the application temperature (140° C. plus shaft temperature) the pinion should be applied on the shaft in exactly the same manner as was done for the cold application. The same man who applied the pinion cold should apply the pinion hot, in order to obtain the same amount of push.




Illus. 12. Assembled Motor, Pinion End

10. Measure the distance the pinion stands off from the end of the shaft in the same manner and position as was done for the cold pinion application. The difference between the hot and cold stand-off readings gives the advance of the pinion on the shaft. This advance must be between 0.120 and 0.130 inch, or the pinion will have to be removed from the shaft and reapplied. The application temperature given is only estimated and may have to be adjusted to obtain the proper amount of advance.

11. The pinion nut should be threaded onto the shaft until solid using the special pinion nut wrench (Westinghouse No. 1331497), as soon as the hot advance has been taken. Screw two setscrews into opposite holes in the pinion nut, using the special wrench (Westinghouse No. 1021196). Tighten the setscrews, strike with a hammer, tighten again, and then lock them by peening the threads. See Illus. 12.

For information on the removal of the traction motor pinion see the article entitled, "TO DISASSEMBLE THE TRACTION MOTOR".

## TO REPLACE TRACTION MOTOR IN TRUCK

1. Block the inner halves of the axle bearings into position so that they remain in their housings during assembly.

2. Lift the traction motor by hooking the lifting chains into the lugs on the motor frame. If three chains are used, their lengths should be adjusted so that the motor will be lowered into position axle end first, and then rotated around the axle into its final position.

3. Slowly lower the motor into position, replacing the air duct assembly when the traction motor approaches the truck frame. The lowering

should be halted when the top of the lower traction motor nose is level with the tops of the two lower truck frame noses.

4. Slide the clamped nose suspension assembly into position. Insert the nose suspension pins; bolt the safety bar into place; and remove the two clamping bolts. The traction motor may now be lowered into its final position.

5. Bolt the two axle caps, with bearing halves, into position. Be sure to replace the shims if they are to be used.

6. Bolt the axle shield into place.

7. Rest the upper half of the gear case in place on the motor frame, and support the lower half. Replace the gear case clips and securely bolt the gear case into position.

## TESTING DIRECTION OF ROTATION

Whenever the traction motor leads have been disturbed, the motors should always be tested for direction of rotation. This test is important, since it is quite possible to have the locomotive apparently operate correctly, and still have an improper connection which would later lead to serious motor trouble.

The test consists of moving the locomotive forward and backward with each pair of motors, while reading the load ammeter. If the locomotive is on level track, the current required to move it in either direction with either pair of motors should be approximately the same.

Any large difference in the current required to move the locomotive under the same conditions with each pair of motors, would indicate an improper connection. If this be the case, the circuit diagram should be consulted and the improperly connected leads changed. Note that reversing, say, the armature leads when the field leads should have been reversed will correct the immediate difficulty, but may lead to confusion later.