SERVICE DEPARTMENT

Electro-Motive Division
Of General Motors
La Grange, Illinois 60525

M.I. 3950-7
*Rev. C

Maintenance Instruction

TRACTION MOTOR OVERHAUL

Traction motor overhaul instructions are presented in seven sections, each under separate cover, and contain detailed instructions to completely disassemble, inspect, overhaul, assemble, and test the traction motor. Refer to Maintenance Instruction 3900 for general or "running" maintenance of the traction motor and also for procedures to remove the traction motor from the locomotive truck. These instructions apply to Models D37, D47, D57, D67, D75, and D77 traction motors unless specifically identified.

Section No.	Title
1	Disassembly
2	Bearing Component Inspection
3	Stator Inspection And Reconditioning - Mechanical
4	Stator Inspection And Reconditioning - Electrical
5	Armature Inspection And Reconditioning
6	Armature Overhaul
▶7	Motor Assembly

SECTION 7

MOTOR ASSEMBLY

INTRODUCTION

This section provides instructions for assembly of the traction motor. After all component parts have been cleaned, checked, inspected, and painted, the traction motor is ready for assembly.

BEARING ASSEMBLY

Particular attention must be given to the proper application of grease to the armature bearings. The following precautions should be observed.

1. All assembly parts must be thoroughly cleaned of all foreign material and previous lubricant. All cleaning solvents must be removed and all parts perfectly dry before applying grease. Keep new or remanufactured bearings in their wrappings until application of grease. The lubricant applied to these bearings, when packaged, is compatible with Shell Cyprina RA Grade 3 grease, therefore, if kept clean, the bearings need not be washed.
2. Shell Cyprina RA Grade 3 grease must be used exclusively and not mixed with other lubricants.
3. Adequate lubrication depends upon precise weight of grease. Too much grease is as detrimental to the service life of the bearing as too little.
4. Cleanliness can be ensured by obtaining grease direct from covered containers by use of a hand or motor driven pump of a type that will not soften or harden (±5 ASTM penetration) the grease during handling. If a pump is not used, extra precaution must be used to prevent contamination of the grease in the pail or drum. Grease should be handled on a clean piece of oil proof paper.
5. A clean steel bladed spatula or putty knife should be used during intermediate handling of the grease, and for greasing the bearing parts. Use of bare hands should be avoided wherever possible to prevent accidental inclusion of dirt or other contaminants.

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

GREASE APPLICATION TO BEARING CAPS

NOTE: The bearing covers are not to be packed with grease until after the bearings have been checked for alignment.

1. Fill all labyrinth grooves in the bearing caps flush with Shell Cyprina RA Grade 3 grease, as shown in Fig. 1. This grease need not be measured.

NOTE: Current model bearing caps and covers do not have labyrinth grooves.

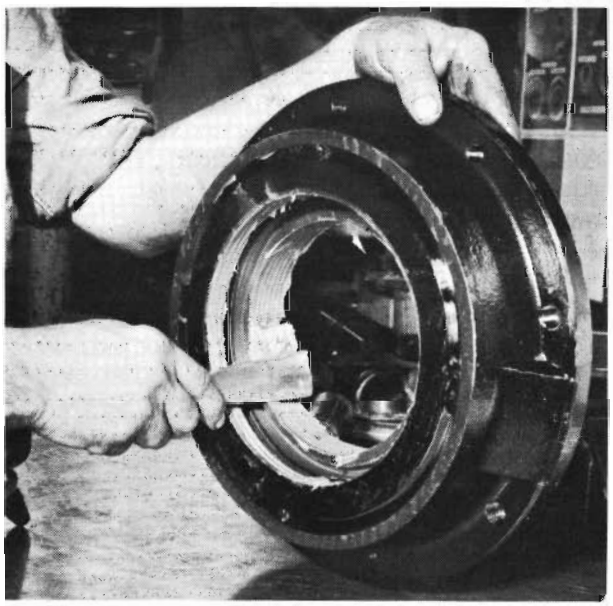

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Fig. 1 - Grease Application To Labyrinth Grooves

2. Weigh the piece of paper that will be used in handling the grease to fill the bearing cap and cover. Weight of paper must be compensated for when weighing grease.

3. For sealed bearings, carefully weigh Shell Cyprina RA Grade 3 grease for specific bearing end to be greased. Refer to Service Data for proper quantity.

NOTE: When anti-churn insert is used with the bearing cap, it is recommended that about two thirds of the weighed grease be applied to the cavity. Then push insert into grease and apply the four locating buttons on the insert into four locating holes in the cap. Finish off grease contour using the balance of the weighed grease.

4. Pack grease solidly into the lower 200°-270° (depending on the particular bearing cap and specified quantity of grease) of the cap. Keep the ungreased portion at the top of the bearing cap as shown in Fig. 2. The bottom of bearing cap has two drain holes.

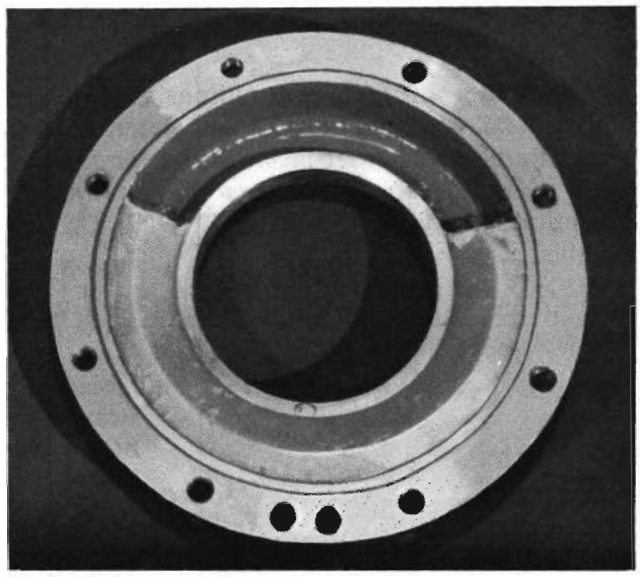

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Fig. 2 - Grease Position

5. Using a spatula or putty knife, roughly form the grease into the approximate desired contour, Fig. 3, and apply correct grease mask as determined from Service Data. The grease arc must be packed without air voids.

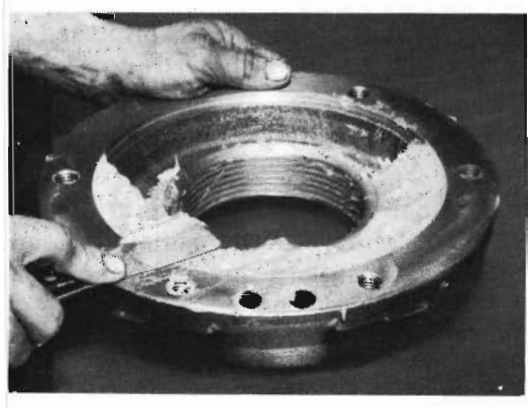

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Fig. 3 - Roughly Formed Grease Contour

6. Rotate grease mask to form proper contour, keeping mask seated as shown in Fig. 4. Several turns may be required to get proper contour. Use spatula or putty knife to fill in low spots with grease from the mask blade. The small amount of grease retained on the

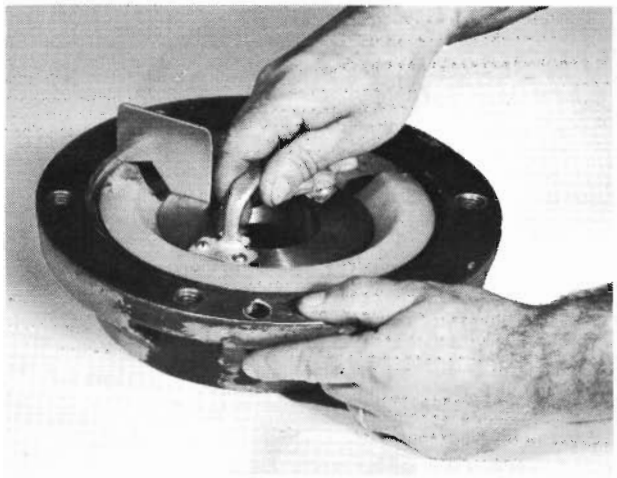

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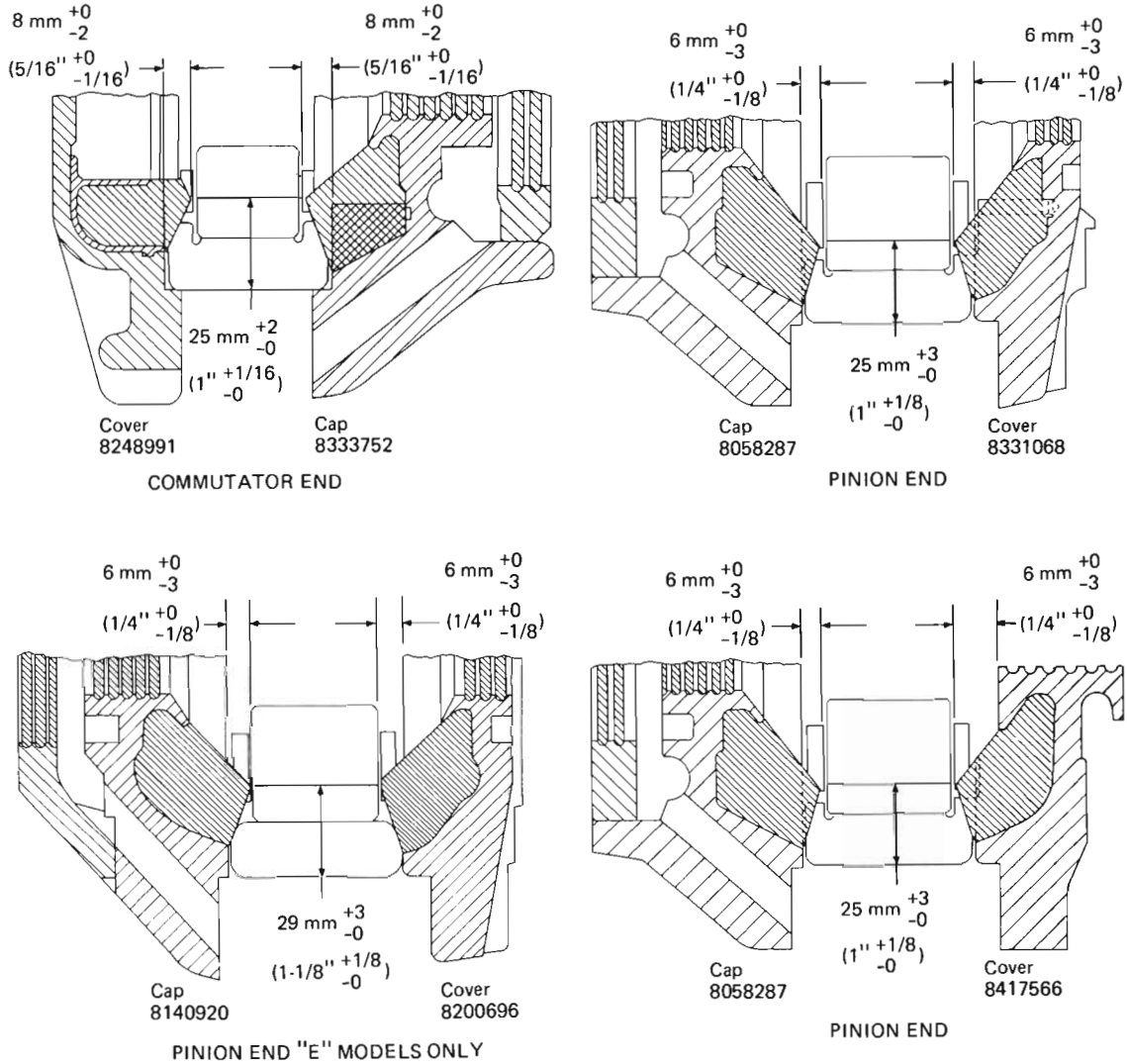
Fig. 4 - Application Of Grease Mask

blade should be removed and applied to the ends of the grease arc. The contour should be built up to the limits of Fig. 5. Fig. 6 illustrates properly packed pinion end and commutator end bearing caps.

NOTE: Current model bearing cap and cover do not have labyrinth grooves and the inner lip has been removed, but the grease contour is identical to the older models.

7. Remove roller cage assembly from bearing outer race. Work grease into the outside diameter of the roller cage assembly with a putty knife or spatula, Fig. 7, coating the



NOTE: The current model bearing cap and cover do not have labyrinth grooves and the inner lip has been removed, but the grease contour is identical to older models.
Commutator End Bearing Cap 9083296 (replaces 8333752)
Pinion End Bearing Cap 9094445 (replaces 8058287)
Pinion End Bearing Cover 9094444 (replaces 8417566)

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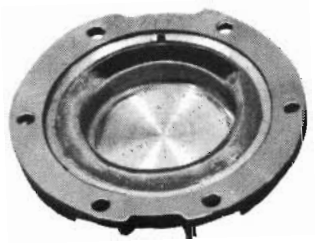
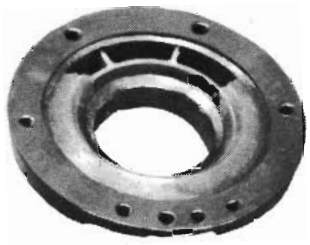
Fig. 5 - Grease Contours



C.E. Bearing Cover



C.E. Bearing Cap

Bearing Outer Race

Bearing

Bearing Inner Race

P.E. Bearing Cover

P.E. Bearing Cap

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Fig. 6 – Proper Application Of Grease

rollers and spreading grease into the cage pockets. Use full amount specified for bearing. Apply some grease between the roller ends and cage end rings. Apply a continuous light coat of grease on the inner race roller paths before assembly of outer race and roller assembly.

8. Replace roller cage in outer race and work grease around the inside diameter of rollers and into the cage pockets.

CAUTION: In removing and replacing roller cage assembly from bearing outer race, ensure cage and outer race are handled squarely to prevent gouging or deforming cage bars on outer race.

OIL LUBRICATED BEARINGS

The method of assembling and aligning oil lubricated bearings is the same as for sealed grease lubricated bearings with the following exceptions:

1. The bearing caps and covers require lubrication only at the labyrinth grooves.

2. The pinion and commutator end bearing covers must have a drilled and tapped hole at the top of the cover to receive lubricating tubes.

3. The commutator end cover will not require the nylon insert.

4. The pinion and commutator end bearings will require 57 to 85 g (2 to 3 oz) of grease for bearing run-in test. Wipe the grease on the rollers of the outer race and roller assembly before assembling to the armature shaft.

5. After the motor has passed the bearing run test 177 cm^3 (6 oz) of SAE No. 30 approved oil should be added to the pinion end bearing and 118 cm^3 (4 oz) of oil to the commutator end. Refer to Maintenance Instruction 1756 for recommended oil.

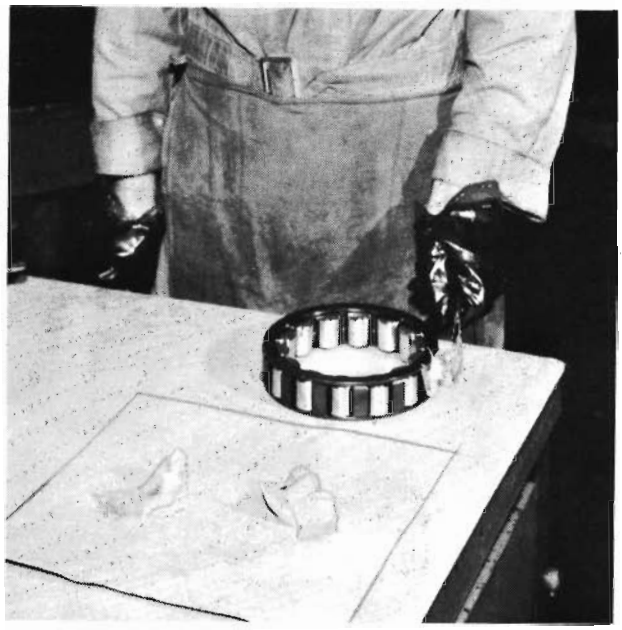

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Fig. 7 – Coating Outside Diameter Of Roller And Cage Assembly

NOTE: The flexible lubricating tube assembly has a button head fitting permanently attached to the tube. Application of oil to armature bearings can only be made by specially designed lubricating oil dispenser 8191382. As this device is equipped with a meter registering in ounces, it is possible to accurately measure the amount of lubricant being dispensed. The meter will not register when air is pumped.

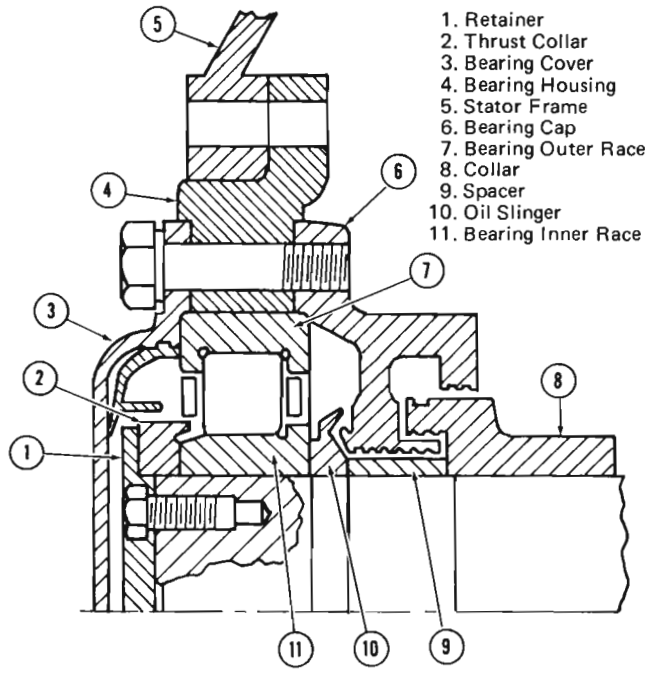
BEARING ASSEMBLY TO ARMATURE

1. Place the armature in a horizontal position on a cradle, supporting the armature on the core section only.

2. Clean shaft diameters and ensure pinion end threads are not damaged. Remove any grit or dust from retaining plate bolt holes on the commutator end of the shaft.

3. Ensure bearing parts are clean. Refer to Figs. 8, 9, and 10 for proper location of bearing assembly.

NOTE: The bearing seal arrangement has been improved effective mid 1976. If replacing commutator end spacer, it is recommended that the current 51.05 mm (2.010") wide spacer 8499802 be used. The current spacer is wider than previous spacer and eliminates the oil slinger.



On current model D77 motors, the commutator end oil slinger and spacer are replaced by one wider spacer. The commutator end collar and bearing cap are replaced with a new configuration.

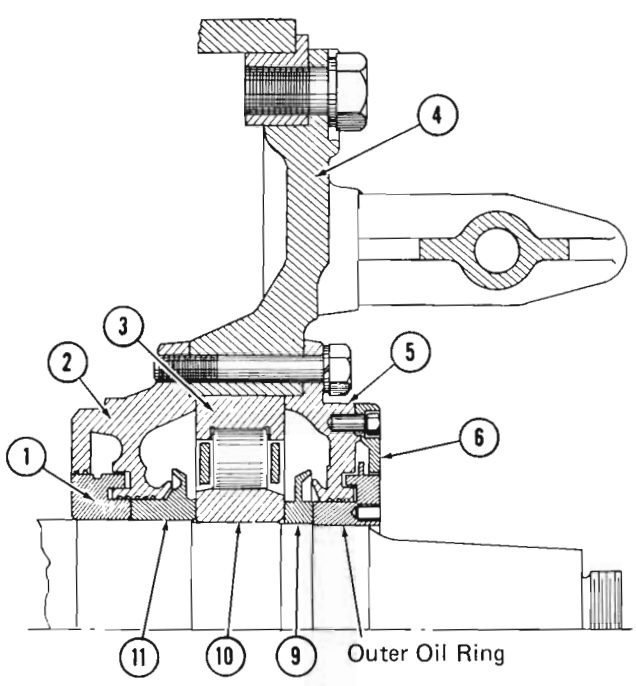
21747

Fig. 8 – Commutator End Bearing Assembly

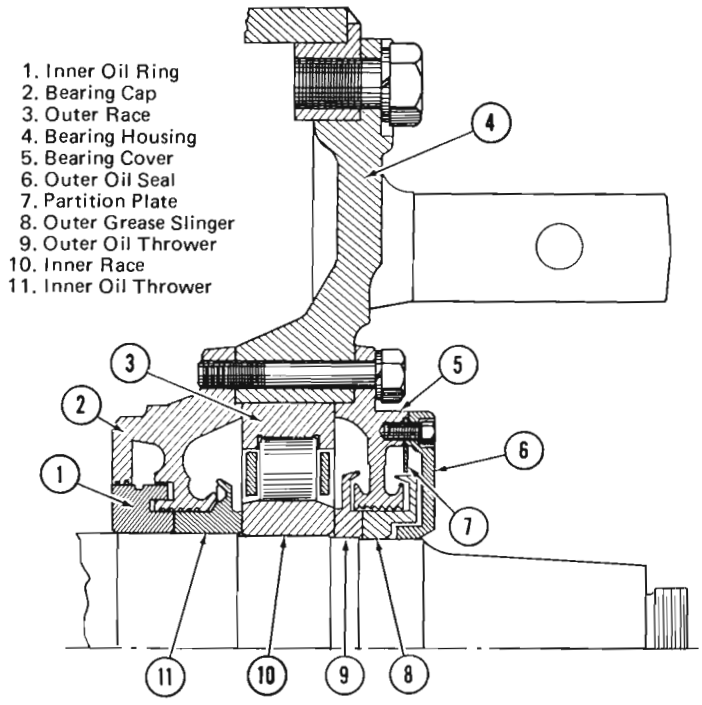
If replacing pinion end inner oil ring and outer grease seal, it is recommended the inner ring be replaced with the current 69.85 mm (2.750") inner oil seal 8499803 and the outer grease seal be replaced with the current 29.743 mm (1.1710") outer grease slinger 8499804. The current parts are wider than replaced parts and eliminate the inner oil thrower and outer oil slinger.

NOTE: A new traction motor support bearing using a seal ring is available to minimize support bearing oil leakage from the inboard end of the bearing. The new support bearing can be used on any model D37 through D77 traction motor using wick lubricator 8277771. The new support bearing is available as a replacement part.

By means of a seal ring that clips around and rotates with the axle in a circumferential seal groove cut into the support bearing bore, any oil that runs out to the end of the bearing opposite the flange is retained and pumped back into the sump through a drilled passage from the seal groove to the wick lubricator window. The flange end of the bearing retains conventional flange wicks to ensure lubrication of the flange.



(D77B Motors Built Prior To 1971)



On current model D77B motors, inner oil ring is wider, eliminating inner oil thrower. Outer grease slinger is wider, eliminating outer oil thrower.

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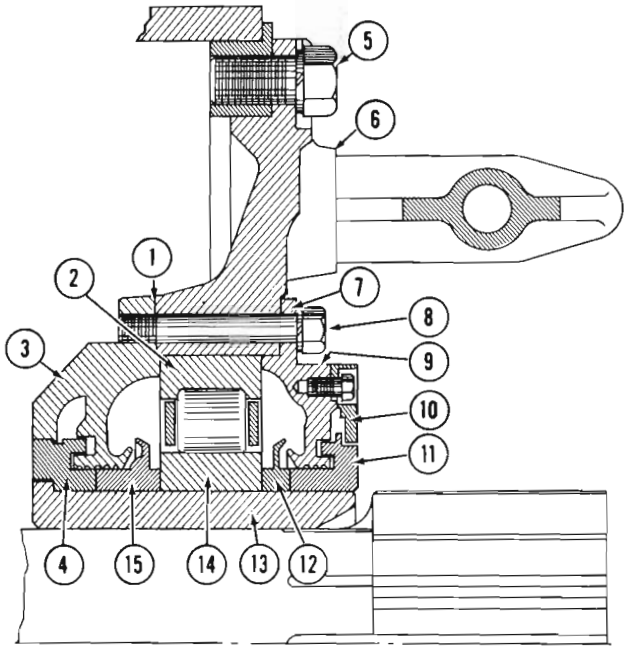
Fig. 9 - Pinion End Bearing Assembly Model "B"



1. Gasket
2. Outer Race
3. Bearing Cap
*4. Inner Oil Ring
5. Housing Bolt
6. P.E. Housing
7. Gasket
8. Bearing Capscrew
9. Bearing Cover
10. Seal
*11. Outer Oil Ring
*12. Outer Oil Thrower
13. Sleeve
14. Inner Race
*15. Inner Oil Thrower

*Effective mid 1976, Item 4 inner oil ring is wider, eliminating Item 15 inner oil thrower. Item 11 outer oil ring is wider, eliminating Item 12 outer oil thrower.

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Fig. 10 - Pinion End Bearing Assembly Model "E"

With the exception that the oil ring must be installed before the lower or window half of the bearing is assembled, bearing installation procedure is unchanged. After the axle is in place against the upper halves of the bearings in the traction motor, the seal rings are threaded into the grooves in the upper bearing shells and around the axle. Do not clip the seal rings around the axle before the axle is dropped in place.

4. Heat the bearing parts to be shrunk on the shaft by suspending parts in SAE 50 oil (with a safe flash point) at a temperature of 115°-125° C (240°-260° F). The oil container should have a false perforated bottom which will prevent direct transmission of heat from the heating unit to the bearing parts. Wipe oil off all bearing parts with clean bound-edge cloths before applying to shaft.

CAUTION: Do not use a torch, induction heater, brazing tongs, or any uncontrolled heat. Direct heating of bearing parts will warp or metallurgically upset the parts.

5. Shrink the commutator end spacer onto the shaft. Ensure the spacer is tight against the

commutator end collar. Turn spacer while holding in place to prevent spacer from seizing the shaft in a cocked position.

NOTE: Use a brass tube large enough to fit over the shaft to hold bearing parts in proper location.

6. Shrink the commutator end and pinion end inner bearing races onto shaft with the serial number facing out. Push each race against the previously applied part and turn inner race; at the same time, exert pressure to hold mating surfaces together. Continue turning inner race under pressure until piece seizes to the shaft. Ensure bearing inner races are not distorted, misaligned, or out of position. Remove all traces of oil from the races.

NOTE: D77 traction motors manufactured since January 1, 1971, are equipped with an offset crown inner race pinion end bearing. When replacing bearings on other models, the offset crown type bearing can be used. However, the bearing parts must be replaced as an assembly. Do not use component parts of the offset crown bearing with parts of the old bearing.

7. Install gaskets to the bearing caps. Pinion end gasket must have enlarged drain hole to match enlarged drain hole in the bearing cap.

8. Using a suitable bearing press. completely support the face surface of the outer roller bearing race and press bearing into the bearing housing. Keep bearing level and not cocked in bore. If bearings have been in service previously, install bearings so that the former top of the outer race (before bearing was removed from the housing) is assembled in a position 90° to either side of the housing top. The face of the commutator end outer race should project 5.08 mm (.200") from each side of the housing when properly seated. The face of the pinion end outer race should be 8.46 mm (.333") from the outer face of the housing.

9. Ensure grease is applied to the bearings before assembling bearings and housings to the armature.

10. Apply a light coating of grease to the bearing inner races and install two locating studs to the pinion end and commutator end bearing caps, Fig. 11. These studs will keep the bearing cap in position when the housings are assembled to the armature. Refer to Service Data for locating stud part numbers.

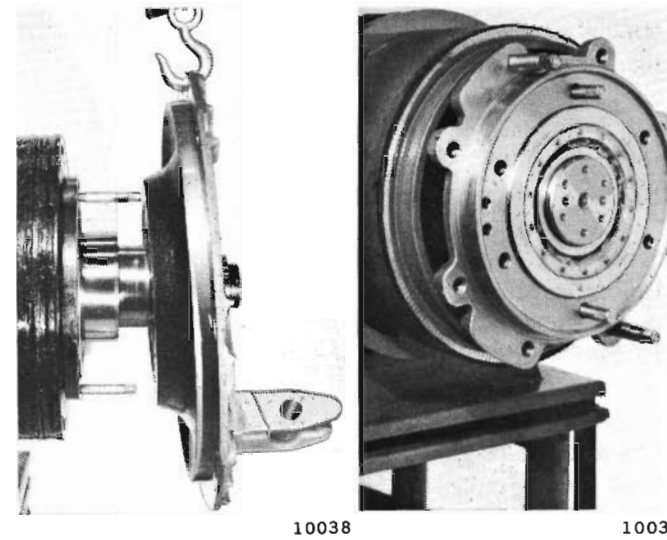

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Fig. 11 - Commutator End And Pinion End Line Up Studs

11. Assemble the bearing housing assemblies to the armature, being careful not to cock or force rollers over inner face.

12. Assemble bearing covers to the bearing assemblies. Remove locating studs.

13. Use four bolts on the pinion end and three bolts on the commutator end to hold covers in position. The covers will have to be removed after armature assembly is placed in the stator to inspect the bearings for alignment.

14. Assemble pinion end lifting eye to the shaft. Install four line-up studs to the commutator end housing and apply turning plate to the commutator end bearing assembly as shown in Fig. 12. Refer to Service Data for locating stud and turning plate part number.

NOTE: Any model motor may be assembled with a D77 armature. However, the armature resistance values will be lower than specified for each specific model motor.

ARMATURE INSTALLATION AND ALIGNMENT

Ensure stator has been cleaned, inspected, repaired, and has the brush holders installed prior to assembly.

1. Place stator on a stand with the commutator end down. Refer to Service Data for stand part number.

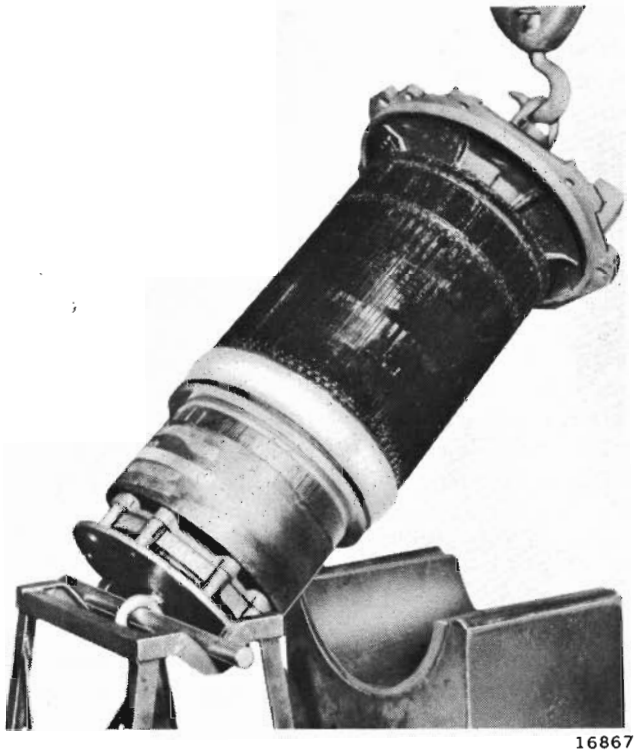

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Fig. 12 – Raising The Armature For Installation Into Stator

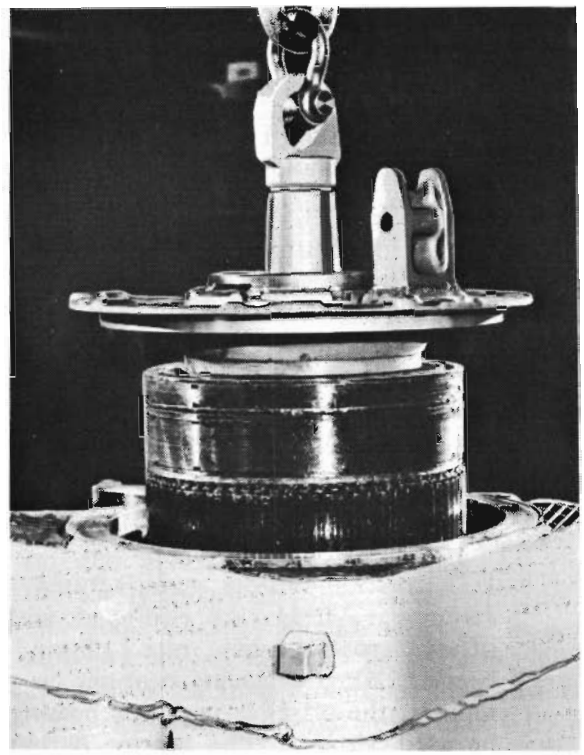

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Fig. 13 – Installing Armature Into Stator

2. Position brush holders all the way against the brush holder blocks to allow clearance for the commutator. Ensure bolt holes in the stator clear the blocks on the stand to allow for the locating pins at the commutator end of the armature to clear as the armature is lowered into the stator. Ensure pinion end bore face is level in all directions. Assemble four locating studs in pinion end housing bolt holes in the stator.

3. Lift the armature into a vertical position, and remove the turning plate. Cover the commutator with a strip of protective paper 1.6 mm x 180 mm x 1 375 mm (1/16" x 7" x 54") to prevent possible damage to the commutator as commutator passes brush holders.

4. Center the armature over the pinion end stator bore and lower armature slowly into the stator. Guide the armature from the top of the stator past the coils and from between the brush holders at the commutator end opening of the frame to position the line-up studs, Fig. 13.

WARNING: Keep hands out of the way of the armature housing and the brush holders.

5. Lower armature into stator until line-up studs are about to contact the stator. Line up the commutator housing studs and pinion end housing cap screw holes with the stator holes.

6. Remove the pinion end guide pins and install pinion end housing bolts and lockwashers, Fig. 14. Do not use a lockwasher with the bottom housing bolt, as clearance is required for the gear case return duct. Equally space three 19 mm (3/4") spacer blocks between the pinion end housing and the bore face. Tighten the pinion end housing bolts evenly until the housing contacts the spacer blocks. Rotate the armature while housing bolts are being tightened to make sure the bearings do not bind. Binding can cause damage to bearings. Remove the three spacer blocks.

7. Remove the traction motor from the assembly stand, using the pinion end lifting eye, and place traction motor in a vertical position on the floor. Using the upper lifting eyes of the traction motor frame, lower the traction motor into a horizontal position. Lift the traction motor and set on a stand so that the pinion end of the traction motor is 75 mm to 100 mm (3" to 4") higher than the commutator end. This is done to keep armature clearance in one direction.

8. Remove commutator end bearing guide pins and install commutator end housing bolts. Carefully tighten pinion end and commutator end housing bolts evenly, Fig. 15. Ensure housings are drawn in evenly and not cocked, keeping the commutator end housing slightly

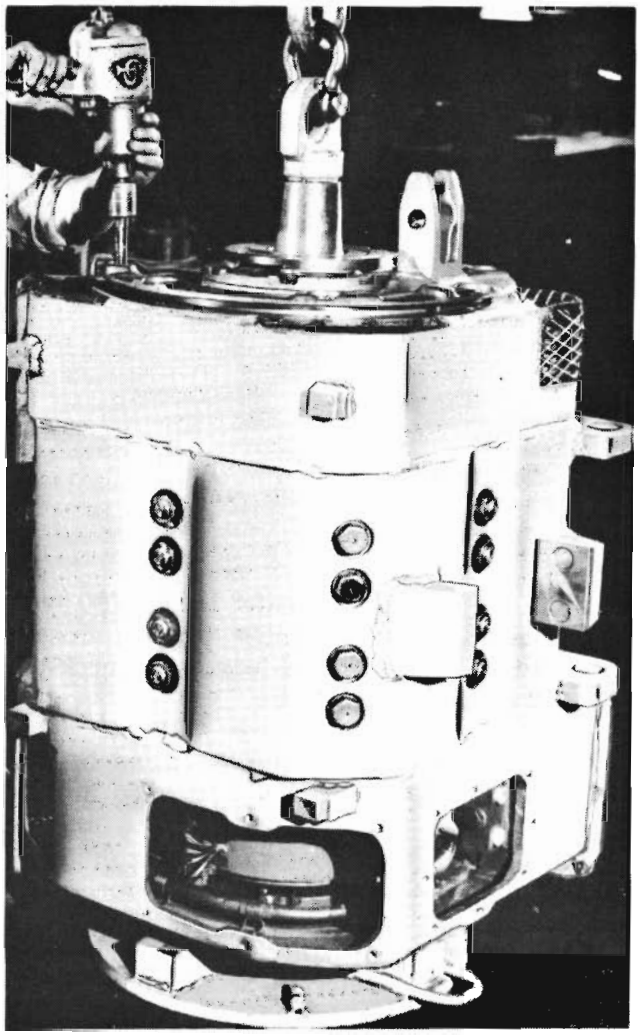

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Fig. 14 – Securing Pinion End Housing To Stator Frame

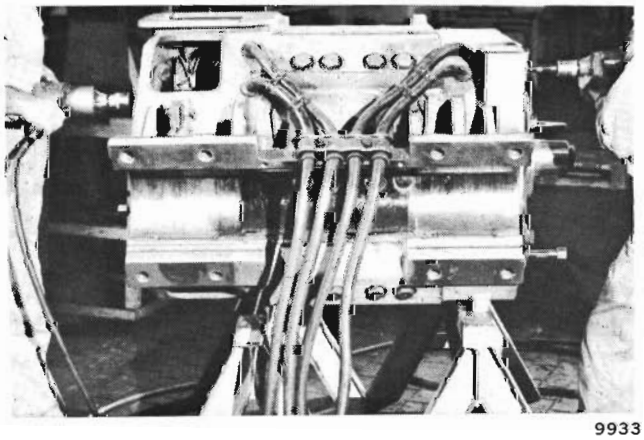

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Fig. 15 – Securing Housings To Stator

ahead of the pinion end housing so that the commutator outer race will at no time be forced out of position in the housing.

9. Assemble commutator end thrust collar and bearing retainer, Fig. 8. Use a new thrust collar when a new commutator end bearing is used. Tighten commutator end thrust collar and bearing retainer with cap screws to pull commutator end bearing into proper position. Assemble commutator end bearing cover with gasket and cap screws and tighten until the lockwashers are set. After tightening cap screws, use a 0 - 407 N·m (0 - 300 ft-lb) torque wrench and torque pinion end housing cap screws, if threads are dry, to 340 - 366 N·m (250 - 270 ft-lbs). If threads are lubricated, torque to 270 - 340 N·m (200 - 250 ft-lbs). Torque commutator end housing bolts, with threads lubricated, to 210 - 224 N·m (155 - 165 ft-lbs).

NOTE: It is very important that the commutator end spacer (inner oil thrower on motors manufactured prior to mid 1976) and bearing inner race faces are tight against each other prior to the following inner race runout check is made.

10. Remove the commutator end cover bearing retainer and remove thrust collar. Clamp an indicator to the frame and check the runout of the bearing race inner face, Fig. 16. Maximum runout should not exceed 0.03 mm (.001") of total indicator reading. If runout exceeds 0.03 mm, the inner race must be aligned. Usually this will require removing the bearing assembly from the armature, checking the runout of the spacer face and reinstalling the bearing assembly.

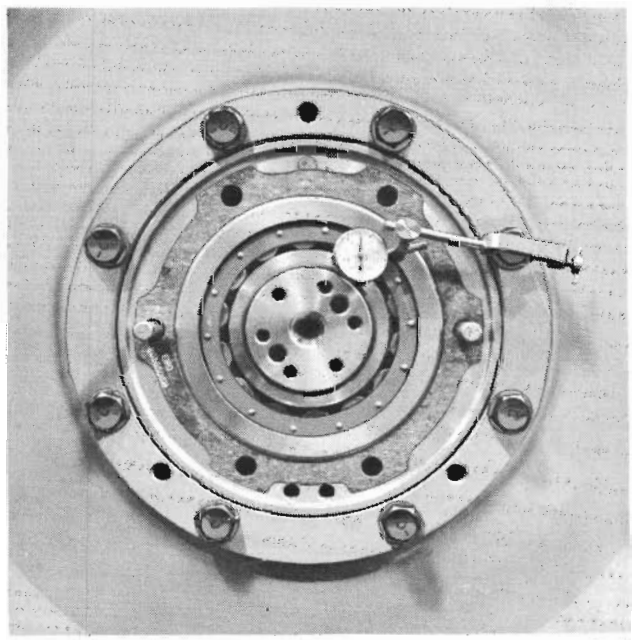

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Fig. 16 – Checking Alignment Of Commutator End Inner Race

11. Check the internal radial clearance between the bearing inner race and rollers by passing a feeler gauge blade under the unloaded rollers at one point. The minimum internal radial clearance after assembly should be 0.064 mm (.0025") when motor is in normal position.

12. If the commutator end bore is greater than 0.30 mm (.012") out-of-round or the radial clearance is 0.089 mm (.0035") or less, check the internal radial clearance with the traction motor axle bore up (motor suspension lugs down). With the motor in this position, the absolute minimum clearance shall be 0.05 mm (.002"). If the clearances are lower, check for tight cage or misalignment.

13. Reassemble commutator end bearing thrust collar and bearing retainer using six 9420945 7/16"-20 bolts. Ensure these special bolts are used. Torque dry bolts in a crisscross pattern to 68 - 75 N·m (50 - 55 ft-lbs).

14. Remove one of the bearing retainer plate bolts and mount indicator to check runout of bearing outer face, Fig. 17. Maximum runout should not exceed 0.064 mm (.0025") total indicator reading. If the outer race is out of square beyond the 0.064 mm, check the runout of the commutator end housing face and align end housing before attempting to check outer race again. Do not force the outer race against the inner bearing cap to align the outer race.

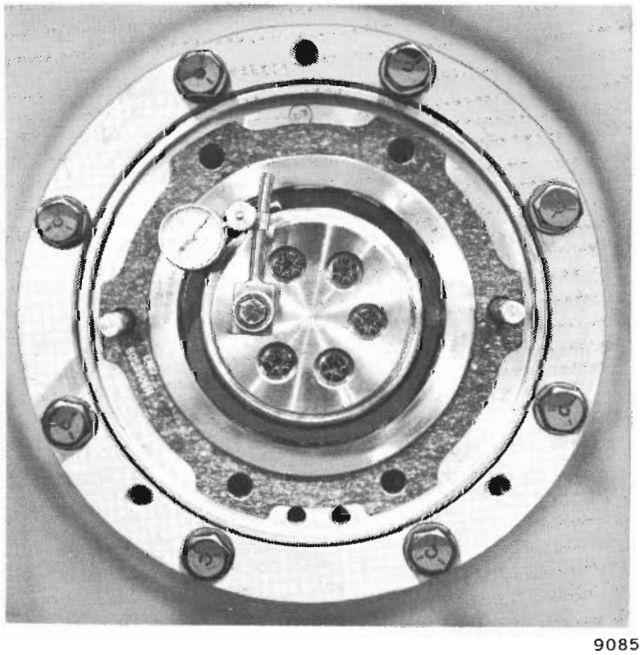

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Fig. 17 – Checking Alignment Of Commutator End Outer Face

15. Position the dial indicator on the bearing outer race.

16. Take up all the bearing end play by pressing on the pinion end lifting fixture (applied to the shaft) with a 450 to 600 mm (18 to 24") steel bar. Set the dial indicator to "0" and pull the shaft towards the pinion end until shaft comes to a definite stop. For new and remanufactured Hyatt bearings, the end play should be 0.140 mm to 0.350 mm (.0055" to .0138").

    Do not force the shaft for this measurement. The commutator end outer race can be shifted or the thrust flanges can be sprung with sufficient force to obtain an erratic indication of from 0.05 mm to 0.38 mm (.002" to .015"). If greater than 0.350 mm, check the commutator end bearing retainer and thrust collar for tightness, and check the thrust collar for wear.

17. Apply grease to the commutator end bearing cover. Refer to Grease Application To Bearing Caps section and apply grease to the commutator end bearing cover using the same procedure. Refer to Service Data for grease quantity and proper grease mask. Ensure commutator end bearing cap has the nylon insert installed. Refer to Section 2 Commutator End Bearing Cover section for machining required to install nylon insert, if required.

18. Inspect bearing cover gasket. If damaged install a new gasket. Install bearing cover to the bearing. Ensure grease arc is at the lower portion of cover, Fig. 18. Apply a small quantity of white lead or thread lubricant to bolt threads to ensure even tightness of all bolts. Apply lockwashers and tighten bolts until lockwashers begin flattening.

NOTE: The bottom of the bearing cover can be determined by the narrow drain slot at the bottom.

19. Torque bolts evenly in the sequence 1-3-5-2-4-6, Fig. 19. If threads are lubricated, torque to 150 - 170 N·m (110 - 125 ft-lbs) or to 170 - 190 N·m (125 - 140 ft-lbs) if threads are dry.

20. Remove pinion end bearing cover. Clamp a dial indicator to the frame and check the runout of the bearing inner race face.

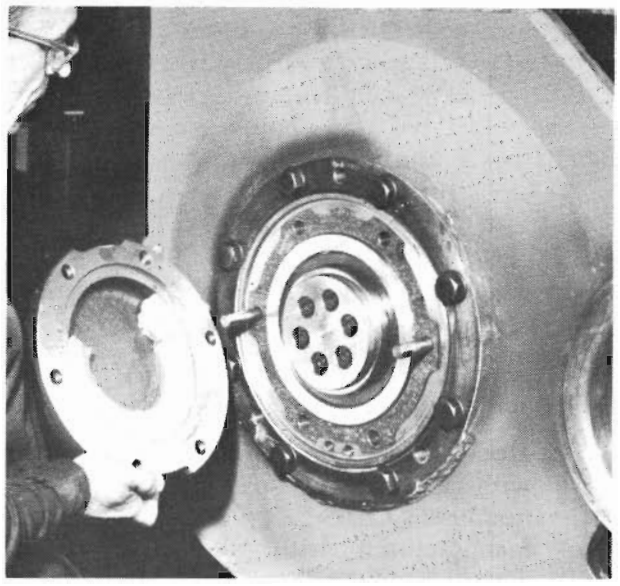

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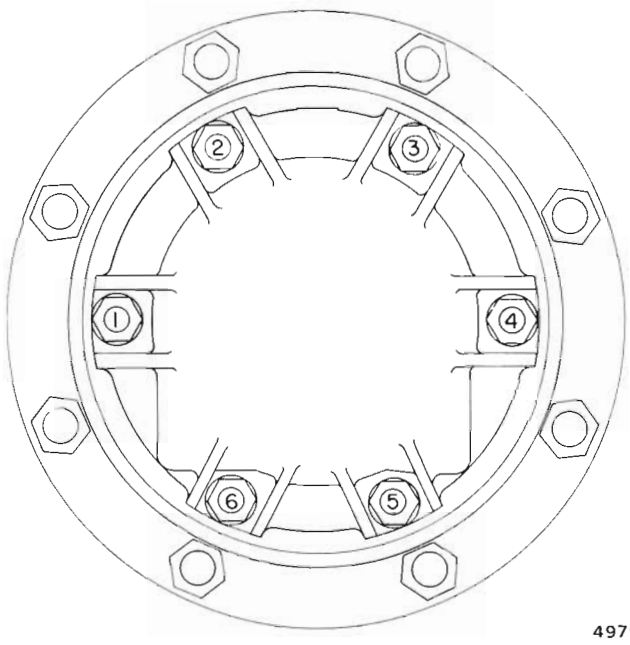
Fig. 18 - Applying Commutator End Bearing Cover

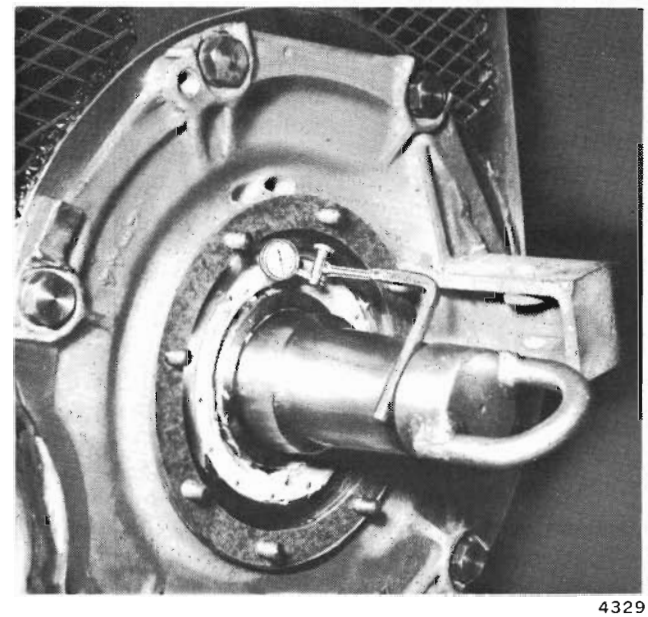


4979

Fig. 19 - Commutator End Bolt Numbering

Maximum runout should not exceed 0.038 mm (.0015"). If runout is greater than 0.038 mm, the inner race must be aligned. Usually this will require removing the bearing assembly from the armature and reinstalling the bearing assembly properly.

21. Clamp a dial indicator on the armature shaft to check the runout of the pinion end bearing outer race face, Fig. 20. Maximum runout should not exceed 0.063 mm (.0025") of total indicator reading.



4329

Fig. 20 - Checking Alignment Of Pinion End Outer Race

22. When motor is in normal horizontal position, check internal radial clearance between the bearing inner race and rollers by passing a feeler gauge blade under the unloaded rollers at one point. The minimum internal radial clearance after assembly shall be 0.08 mm (.003").

23. If the pinion end bore is greater than 0.31 mm (.012") out-of-round or the radial clearance is 0.089 mm (.0035") or less, check the internal radial clearance with the traction motor axle bore up (motor suspension lugs down). With the motor in this position, the absolute minimum clearance shall be 0.05 mm (.002"). "E" model internal radial clearance shall be 0.08 mm (.003"). If clearances are lower, check for tight cage or misalignment.

24. Shrink the pinion end outer grease slinger (outer oil thrower on motors manufactured prior to mid 1975) to the shaft and hold it against the bearing inner race rotating the grease slinger until it seizes to the shaft.

25. Apply grease to the pinion end bearing cover. Refer to Grease Application To Bearing Caps section and apply grease to the pinion end bearing cover using the same procedure. Refer to Service Data for grease quantity and proper grease mask.

26. Inspect bearing cover gasket. If damaged install a new gasket. Install bearing cover to the bearing. Ensure grease arc is at the lower portion of the cover. Apply a small quantity

of white lead or thread lubricant to bolt threads to ensure even tightness of all bolts. Apply lockwashers and tighten bolts until lockwashers begin flattening.

NOTE: The bottom of the bearing cover can be determined by the 83 mm (3-1/4") drain slot at the bottom.

27. Torque bolts evenly in the sequence 1-3-5-7-2-4-6-8, Fig. 21. If threads are lubricated, torque to 150 - 170 N·m (110-125 ft-lbs) or to 170 - 190 N·m (125 - 140 ft-lbs) if threads are dry.

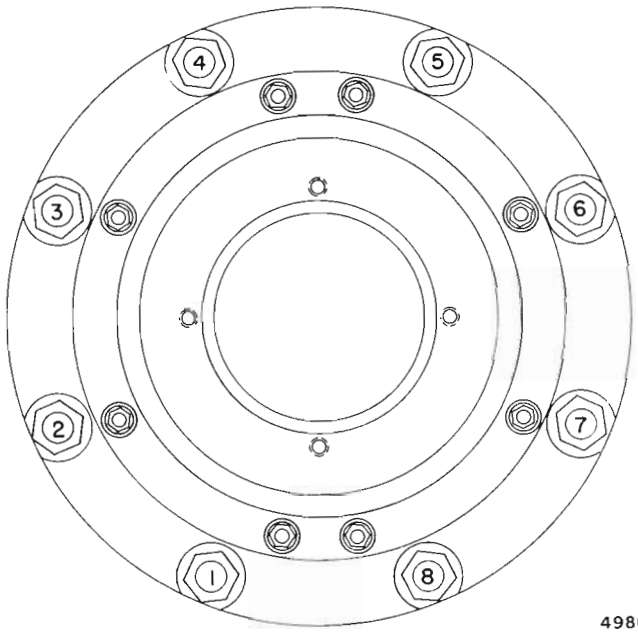


Fig. 21 – Pinion End Bolt Numbering

28. On model D77 motors, assemble partition plate to bearing cover. Ensure plate fits freely and will not bind or distort when outer oil seal is in place.

29. On motors with the bearing arrangement of models manufactured prior to mid 1976, shrink the pinion end outer oil ring (outer grease slinger on models with seal arrangement manufactured after January 1, 1971) to shaft and hold it against the outer oil thrower, rotating oil ring until it seizes to the shaft. Assemble grease seal (outer seal on models with 1971 seal arrangement) and secure with lockwashers and cap screws. Ensure slotted half of grease seal is assembled to bottom side of shaft.

30. On model D77 motors, check bottom opening for grease drain to ensure that partition plate is flat and contacts outer seal to provide return duct to gear case.

31. Remove protective paper cover from commutator and adjust brush holders so that the bottom faces of the brush slots are 3 to 5 mm (1/8"-3/16") above the commutator surface. Torque brush holder clamp bolts to 200 - 220 N·m (150 - 160 ft-lbs) after obtaining clearance.

32. On TIG welded commutators, check clearance between commutator riser face and riser side of brush holder. Minimum clearance is 3 mm (1/8").

NOTE: Model D67 and D77 motors are equipped with three wafer padded brushes part number 9322057 or 9322058 which are manufactured with a contour at the commutator end of the brush. These brushes will not require sanding.

33. Install brushes to brush holders. If old brushes are to be used, they should be installed in the same position in brush holder from which they were removed. When new brushes are installed, they must be "sanded in" by wrapping 1-1/2 turns of medium gauge sandpaper (with the abrasive side out) around the commutator before the brushes are applied. Install brushes and rotate armature until all the brushes are seated.

34. If new brushes were sanded in, remove sandpaper and blow out carbon dust with clean, dry compressed air at reduced pressure. Use a clean, dry, bound-edge cloth to remove carbon from string band and commutator riser while manually rotating the armature. Wipe carbon dust from brush holder insulators.

35. Visually inspect the commutator surface and creepage surface for damage or dirt. Rework as required. Refer to Section 5.

36. Connect brush shunts to brush holders. Torque bolts to 15 - 20 N·m (10 - 15 ft-lbs).

37. Apply and secure axle caps to traction motor frame. Ensure proper axle cap bolt and washer combination are used:

    Axle cap bolt 8300107 and plate washer (dog eared) 8300066 should be replaced by axle cap bolt 8135061 and lockwasher 8135054. The new lockwasher is much thicker than the old washer so the new bolt is 6 mm (1/4") longer.

Also available is a hardened steel flat washer 8495681 as a replacement for lockwasher 8135054. Flat washer 8495681 has a larger and smoother seating area which results in a higher clamp load. The new flat washer is directly interchangeable with the lockwasher. If the mounting spot face on the axle is galled, the spot face should be welded and machined to the dimensions of Fig. 22.

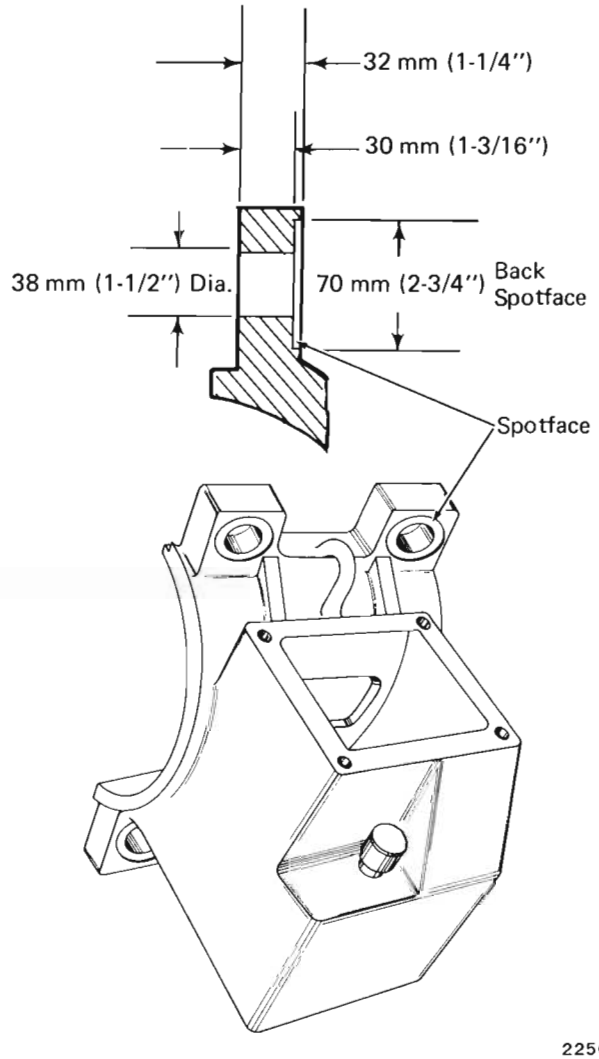


Fig. 22 - Axle Cap Mounting Spot Face Remachining

The new bolt has class 3 threads instead of class 5 threads, eliminating the interference fit.

Axle cap nut 8300147 should be used with the new bolt 8135061. The new nut allows for a class 3 tolerance rather than a class 5 tolerance. The change is minor and the old nut can be used with a new bolt.

Current model D77 frames have a 1-3/8"-7 thread for the axle cap bolts, eliminating the nut. A 76 mm (3") bolt 8242193 is used.

Also available is a 152 mm (6") long axle cap bolt 9095753 with a hardened spacer for application on the lower pinion side axle cap position. Spacer 9318880 is used for cast frames and spacer 9318786 is used for fabricated frames. The longer bolt allows for increased stretch over the 76 mm (3") bolt 8242193. This longer bolt and spacer are recommended in areas where the standard bolt loosens in service. The increased stretch (2-1/2 times greater) decreases the effect of initial stretch losses. The long bolt is interchangeable with the standard bolt and is torqued to the same value. The hardened steel washer 8495681 must not be used when installing the long bolt.

38. Ensure axle cap serial number corresponds to traction motor frame number. If a new axle cap was line bored to the traction motor frame, ensure the frame number is stamped on the axle cap.

39. Remove pinion end lifting fixture from armature shaft.

PINION APPLICATION

It is essential that the pinion is properly mounted on the armature shaft to ensure it is fit with the proper tightness. Apply the pinion as follows:

1. Remove any burrs or scoring on armature shaft or in pinion bore by honing or cleaning away with Arkansas stone (novaculite) or Grade 240 abrasive cloth.

2. Clean threads on armature shaft with a wire brush, or if threads are damaged, run on a thread chasing die. Apply retaining nut to shaft to check for proper fit.

3. Thoroughly clean pinion bore and tapered end of armature shaft where pinion will be mounted. The slightest bit of lint or dirt will hinder pinion application.

4. Check the contact between the pinion and shaft taper as follows:

   a. Apply a thin, even coat of Prussian (nondrying) bluing compound to the pinion bore with the fingers. A cloth should not be used since heavy deposits of bluing will not allow a true indication of fit.

b. Place the pinion on the shaft carefully, avoiding undue rubbing. With the pinion held snug on the shaft, rotate pinion approximately one-eighth turn and back. Remove the pinion carefully and inspect the amount of bluing transferred to the shaft and the areas of contact.

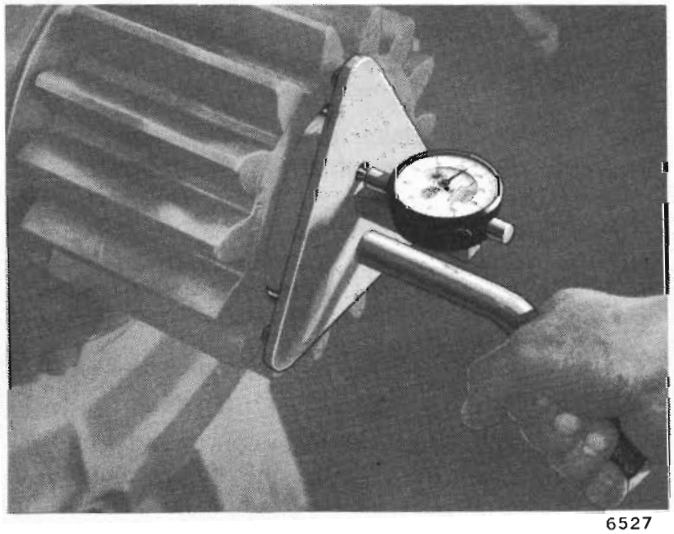
It is necessary that the pinion is in firm contact with the small end of the armature shaft taper. A 50% contact is expected, but if the two tapers are at opposite extremes of tolerance, it is required that the pinion is in firm contact with at least 20% at the small end of the armature shaft taper. The large end of the bore should not contact unless a line-to-line contact is obtained throughout the bore.

c. If correction is required, polish the shaft with Arkansas stone (novaculite) or Grade 240 abrasive cloth.

d. Thoroughly clean and remove all traces of bluing from the shaft and pinion with a solvent and wipe dry with clean, disposable tissues.

5. With armature shaft and pinion at room temperature, lightly mount pinion on shaft to ensure proper alignment. Withdraw pinion about 12.7 mm (1/2") and then using both hands, push firmly in place as far as it will go. Ensure pinion is mounted squarely on shaft.

6. Measure and record pinion position with respect to the shaft with a micrometer depth gauge, Fig. 23.



6527

Fig. 23 – Measuring Pinion Advance

7. Mark the points of measurement on the pinion, then mark the end of the shaft and pinion to retain the same angular relationship when re-applying and for final installation.

8. Remove pinion. If this proves difficult, small steel wedges may be used between the pinion and the frame. To prevent damage to the bearing housing, a strip of copper should be placed between wedge and housing.

9. Repeat Step 4, using the mating marks previously made to ensure proper relationship of pinion and shaft.

10. Apply micrometer depth gauge to markings and again measure and record pinion position on the shaft. Compare readings to those previously taken in Step 5. A minimum of two such readings should be made to determine variations, if any, in readings. To be acceptable for final mounting, successive cold readings should not vary more than 0.05 mm to 0.08 mm (.002" to .003").

If variation exceeds these limits, again carefully clean pinion bore and armature shaft to eliminate all possibility of dirt or contamination. If the variation is as much as 0.25 mm (.010"), the pinion fit to armature shaft must be checked by bluing and corrections made by lapping. It is necessary that the pinion is in firm contact with at least 20% at the small end of the armature shaft taper. The large end of the bore should not contact unless a line to line contact is obtained throughout the bore.

11. When cold mounting variations are within limits, the pinion may be heated with an induction heater, Fig. 24, for final mounting. Heat and mount the pinion as follows:

NOTE: In Step a, the use of liquid cleaner on the shaft and pinion bore increases the friction or holding power between the pinion and the shaft, preventing most pinion slipage. The liquid cleaner should not be used on larger pinions as it will make pinions extremely difficult to remove.

a. When applying 15-tooth and smaller pinions to the armature shaft, the bore of the pinion must be brushed clean and liquid cleaner applied liberally with a clean brush. After approximately 15 seconds (the liquid cleaner must not be

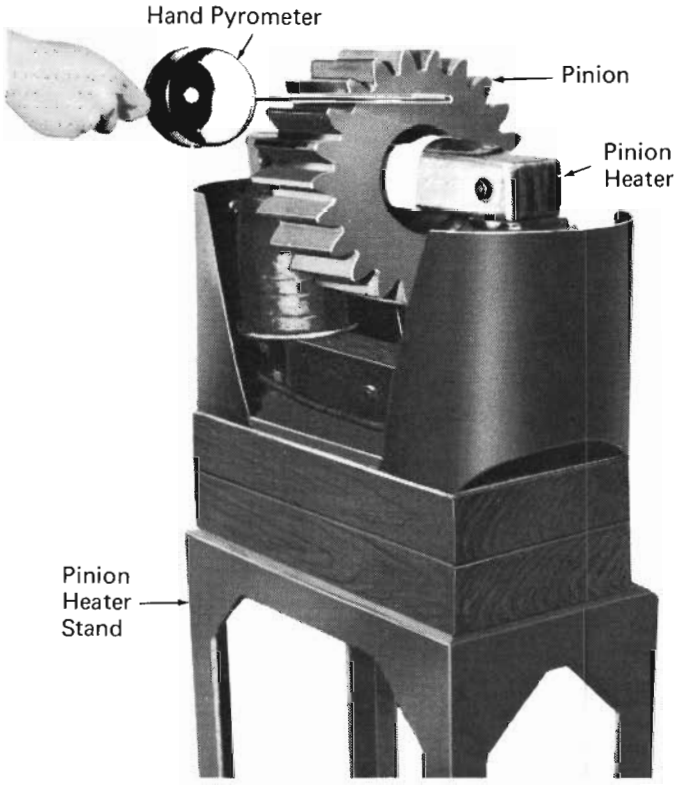


Fig. 24 – Induction Heater

allowed to dry), use clean paper towels to carefully wipe the cleaner out of the bore, being careful not to touch the surface with the hands. Protect the pinion bore surface with a clean paper towel. Refer to Service Data for liquid cleaner part number.

Just before pinion application (in Step c), liberally apply liquid cleaner to the shaft and allow to set for 15 seconds and wipe off cleaner with clean paper towels. Do not allow shaft or pinion surface treated with liquid cleaner to be exposed to dirt or oil and do not touch with the hands.

NOTE: The effectiveness of liquid cleaner is reduced after extended storage. Cleaner stability is at least 6 months if stored at temperatures below 24° C (75° F). Reduced stability will result if the cleaner is stored at higher temperatures.

b. Heat pinion to the temperature specified in the Service Data. Check temperature at various points on the pinion with a hand pyrometer. Take readings ONLY when current to the induction heater is turned off. Pinion temperature should NEVER exceed 190° C (374° F).

NOTE: Since a change of 1° C is equivalent to a change of 1.8° F, a 121° C rise in temperature is therefore equivalent to a rise of 218° F.

As an example of proper heating, assume the shaft temperature is 24° C (75° F). The pinion should then be heated to obtain 145° C (293° F), which is the desired 121° C (218° F) rise in temperature over that of the shaft.

c. When pinion is heated to the proper temperature, mount the hot pinion on the shaft in the same position used for the cold mountings.

d. Measure pinion position with respect to the shaft with a micrometer depth gauge. Refer to Service Data for proper pinion advance. If pinion advance is not within limits specified in Service Data, the pinion will have to be removed and all preceding steps repeated after parts have cooled to room temperature.

e. Place the pinion retaining nut into the cup lockwasher.

NOTE: In Step f, reused pinion retaining nut should be checked for flatness prior to assembly, using a straightedge and feeler gauge. The dish, if any, should be noted so an additional 0.10 mm (.004") dish can be determined in Step f.

f. After final correct mounting of the heated pinion, quickly tighten the pinion retaining nut (with cup lockwasher) before the shaft and pinion temperatures equalize. Check for tightness of the nut 10 minutes after application, by measuring nut dish 6.4 mm (1/4") from inside the chamfer, using a straightedge and feeler gauge. A minimum dish of 0.10 mm (.004") is necessary. If nut face dish is less than 0.10 mm (.004"), the nut must be retightened. A minimum dish of 0.08 mm (.003") is required when nut face is checked cold.

g. Secure the pinion retaining nut by staking the cup lockwasher into the two notches in the pinion and stake the cup lockwasher into two notches of the retaining nut.

SUPPORT BEARING OIL FILLER CAP

Current traction motor models have an improved oil filler cap 9333024 replacing oil filler cap 8319096. During overhaul it is recommended that the old cap be replaced with the new cap.

The old cap consists of a threaded metal base and a hinged flip top. The hinged top is susceptible to broken hinges and leakage.

The new cap, Fig. 25, consists of a cap held firmly in place with a coil spring. The cap requires no maintenance and will last much longer than the old cap.

Both caps have 3/4" NPT thread for installation and are directly interchangeable.

BEARING RUN

Run the traction motor at 1500 RPM for 2 hours or until the bearing temperature stabilizes. It requires approximately 125 V DC and 50 amperes per motor to run bearing test. The average temperature rise is 15° C (27° F) above room temperature. The high limit rise above room temperature is 25° C (45° F) at the commutator end and 35° C (63° F) at the pinion end.

During bearing run, take temperature readings every 15 minutes. Also check for noise and roughness, which indicate faulty assembly (misalignment of bearings), dirty bearings, or armature unbalance.

After completion of bearing run, visually inspect the commutator and wipe off any carbon dust from the creepage surface.

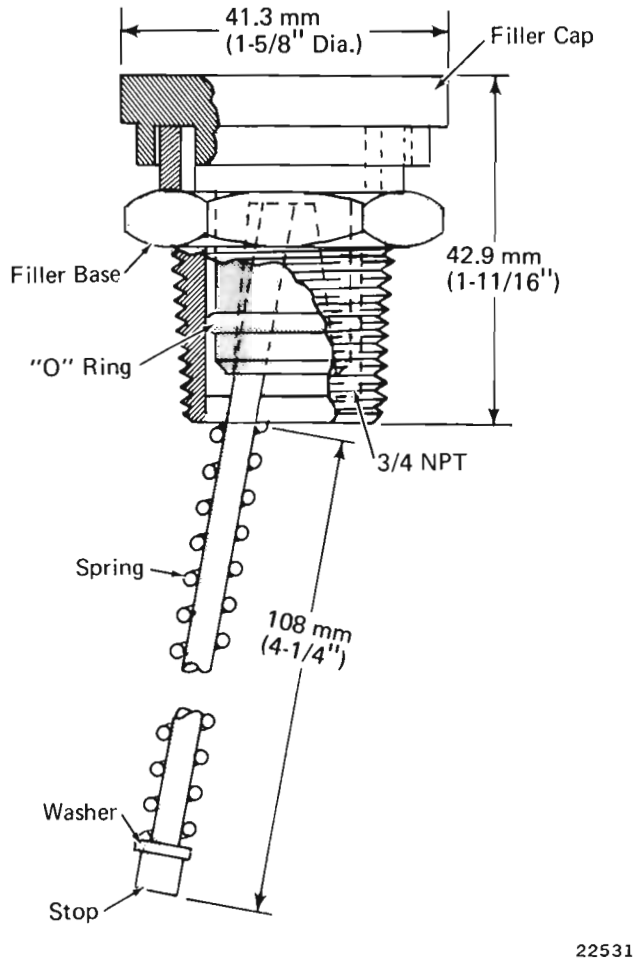


Fig. 25 - Support Bearing Oil Filler Cap

SERVICE DATA

SPECIFICATIONS

D37, D47, D57 BRUSHES

	Part No.
Two wafer, flat top (54 mm x 51 mm x 16 mm [2-1/8" x 2" x 5/8"]) Grade DE-5	8215949
Two wafer, flat top (56 mm x 51 mm x 16 mm [2-3/16" x 2" x 5/8"]) Grade AC-124	9322055
Two wafer, flat top (56 mm x 51 mm x 16 mm [2-3/16" x 2" x 5/8"]) Grade DE-7	9322056

D67, D75, D77 BRUSHES

	Part No.
Three wafer, floating center wafer (62 mm x 51 mm x 16 mm [2-7/16" x 2" x 5/8"])	
Grade DE-7	8481803
Grade DE-7	9322058
Grade AC-100	9322059
Grade AC-124	9096381
Grade AC-124	9322057
Two wafer, flat top (56 mm x 51 mm x 16 mm [2-3/16" x 2" x 5/8"])	
Grade AC-124	9093639
Grade AC-124	9322055
Grade DE-7	9322056

Pinion Application

	Advance	Approximate Rise Above Shaft Temperature
15 to 18 teeth	1.40 mm ± 0.13 mm (.055" ± .005")	121° C (218° F)
19 to 21 teeth	1.27 mm ± 0.13 mm (.050" ± .005")	110° C (198° F)
22 and 25 teeth	1.14 mm ± 0.13 mm (.045" ± .005")	99° C (178° F)

Torque Values

Pinion End Housing Cap Screws	
Lubricated	270 - 340 N·m (200 - 250 ft-lbs)
Dry	340 - 365 N·m (250 - 270 ft-lbs)
Commutator End Bearing Housing Bolts Lubricated	210 - 224 N·m (155 - 165 ft-lbs)
Pinion End Bearing Cover Cap Screws	
Lubricated	149 - 169 N·m (110 - 125 ft-lbs)
Dry	170 - 190 N·m (125 - 140 ft-lbs)
Commutator End Bearing Cover Cap Screws	
Lubricated 149 - 169 N·m (110 - 125 ft-lbs)	
Dry	170 - 190 N·m (125 - 140 ft-lbs)
Commutator End Bearing Retaining Plate Bolts Dry	70 - 75 N·m (50 - 55 ft-lbs)
Brush Holder Clamping Bolts Dry	200 - 220 N·m (150 - 160 ft-lbs)
Brush Shunt Terminal Lugs To Brush Holders Dry	15 - 20 N·m (10 - 15 ft-lbs)
Brush Holder Cable Terminal Connection Dry	95 - 102 N·m (70 - 75 ft-lbs)

Weights (approximate)

Complete Traction Motor	2 790 kg (6150 lbs)
Armature	820 kg (1810 lbs)
Gear Case	68 kg (150 lbs)

EQUIPMENT LIST

Grease Masks

"B" and "E" Model - Commutator End Cover, Without Insert	8228023
"B" and "E" Model - Commutator End Cover, With Insert	8252767
"B" and "E" Model - Commutator End Cap	8228024
"E" Model - Pinion End Cap And Cover	8238744
"B" Model - Pinion End Cap And Cover (built prior to January 1, 1971	8228025
"B" Model - Pinion End Cap And Cover (built after January 1, 1971	File No. 777
Locating Studs - Pinion End Bearing Cap	8155976
Locating Studs - Commutator End Bearing Cap	8155977
Lifting Fixture, Pinion End Shaft, "B" Model	8067122
Lifting Fixture, Pinion End Shaft, "E" Model	8065527
Turning Plate, Commutator End	8067147
Stand, Traction Motor Frame	8064917
Rethreading Die, Armature Shaft	8050721
Die Holder	8057022
Brush Spring Lifter	8140869
Retaining Nut Wrench	8127529
Sliding "T" Handle	8127528
Depth Gauge, Pinion Advance	8160273
Oil Dispenser	8191382

MATERIAL LIST

Armature Bearing Lubricant

Sealed Application - Shell Cyprina RA Grade 3
15.9 kg (35 lb Pail) 8249819
54.4 kg (120 lb Drum) 8249820

Sealed Bearing Lubricant Quantity ± 7 g (1/4 oz)

	PINION END		COMMUTATOR END	
D77B Models Manufactured Or Rebuilt After January 1, 1971	Kilograms	Ounces	Kilograms	Ounces
Cover	0.227	8	0.170	6
Cap	0.397	14	0.198	7
Roller Cage O.D.	0.057	2	0.028	1
Roller Cage I.D.	0.057	2	0.028	1
	0.738	26	0.424	15
All "B" Models (except above)				
Cover	0.340	12	0.170	6
Cap	0.397	14	0.198	7
Roller Cage O.D.	0.057	2	0.028	1
Roller Cage I.D.	0.057	2	0.028	1
	0.851	30	0.424	15
All "E" Models				
Cover	0.397	14	0.170	6
Cap	0.482	17	0.198	7
Roller Cage O.D.	0.057	2	0.028	1
Roller Cage I.D.	0.057	2	0.028	1
	0.993	35	0.424	15

Liquid Cleaner (pinion application)

19 litre (5 gal) Can 8365668

NOTE: The effectiveness of liquid cleaner is reduced after extended storage. Cleaner stability is at least 6 months if stored at temperatures below 24° C (75° F). Reduced stability will result if the cleaner is stored at higher temperatures.

Litho in U.S.A.