ELECTRO-MOTIVE

MAINTENANCE INSTRUCTION

M.I. 3904
*Rev. B

GENERAL MAINTENANCE — TRACTION MOTORS MODELS D19, D29, D29CC, D29CC-7, D31, D36

INTRODUCTION

This Maintenance Instruction contains general or "running" maintenance recommended for traction motors. It includes a procedure for removing a traction motor from a locomotive and various inspections which should be made in such instances. Refer to M.I. 3952 for detailed instructions to disassemble, inspect, overhaul, assemble, and test the traction motor. Refer to recommended maintenance intervals specified in the applicable Scheduled Maintenance Program.

These instructions apply to Models D19, D29, D29CC, D29CC-7, D31, and D36 traction motors unless specifically identified. References to Model D29 motors will include Models D29CC, D29CC-7, and D31 unless specifically identified.

DESCRIPTION

The D19, D29, D29CC, D29CC-7, D31, and D36 traction motors are similar in appearance and are of the same general size, Fig. 1. The construction of the internal parts limits interchangeability of the parts. If different model traction motors are being disassembled for maintenance, components must be identified so they can be reassembled into the same model traction motor.

CLEANING

It is essential that the traction motor be kept as clean as possible, both on the inside and outside.

Oil and grease soaked dust and dirt should not be allowed to accumulate as this can prove detrimental to insulation and motor performance in general.

Cleaning the outside of the motors can be done by the common method of using a steam jet at the same time the trucks, underframe and fuel tank are washed. If this method is used, the diesel engine must be running at about 450 RPM to force sufficient traction motor blower air through the motors to prevent water or moisture from entering.

The motor interior can be conveniently cleaned by blowing dust and dirt away with compressed air. A large volume of clean, dry compressed air should be used at a reasonable low pressure. Blasts of high pressure air should be avoided due to the possibility of loosening or damaging the protective coating on the insulation.

Clean, dry lintless cloths should be used in conjunction with the air to clean away heavier deposits of dirt, and for wiping the brush holder insulators.

In cases where air and dry wiping cloths prove incapable of removing caked grease and dirt, a stiff brush, soft wood or fibre scrapers may be used. In severe cases it may be necessary to dampen a cloth in solvent such as Stoddards Solvent to loosen and remove imbedded deposits. Every precaution should be taken to keep the solvent off the commutator and copper parts.

CAUTION

Adequate ventilation and safety precautions are necessary when handling inflammable fluids such as Stoddards Solvent (flash point 46° C [115° F]).

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

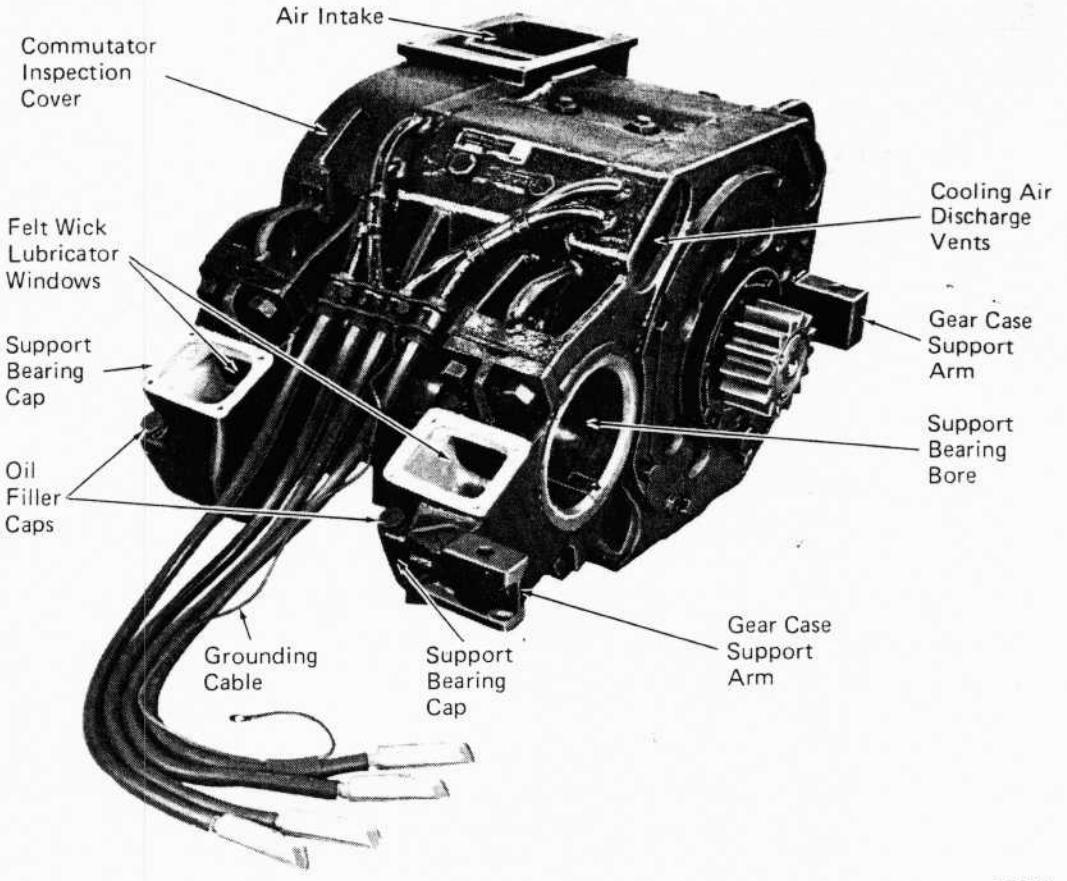

Fig. 1 - Model D29 Traction Motor

Chlorinated hydrocarbon type cleaning solvents are not recommended for use on the equipment because of their effect on the insulation system. They have a tendency to attack semi-cured silicone rubber and to swell ethylene propylene rubber, natural rubber, neoprene and hypalon during extended soaking periods. The vapor state at 71° C (160° F) attacks uncured silicone rubber within 20 minutes. These solvents and their vapors also have an adverse effect on commutation. Special care is also necessary to avoid subjecting the polyester glass insulated brush holder studs to alkaline type cleaning solutions.

COMMUTATOR BRUSH HOLDERS

NOTE

Current motors are equipped with constant pressure spring type brush holders which will accept a longer brush. This longer brush reduces maintenance by extending the period between brush changeouts. Older model traction motor brush holders can be modified to use the constant pressure spring cell, but if the longer brush is desired, the new style brush holder should be purchased.

CONSTANT PRESSURE SPRING TYPE BRUSH HOLDER

Constant pressure spring type brush holder spring pressure is pre-set and cannot be adjusted; however, if there is reason to suspect loss of spring pressure from some cause, such as heat from a commutator flashover, spring pressure should be checked. It is difficult to check brush holder spring pressure accurately with the brush holder in place, and it is recommended that the brush holders be removed.

The spring pressure of a new spring with the spring cell in the brush holder should be within 1.8 to 2.3 kg (4 to 5 lbs) at each of the two springs as measured with a spring tension scale at the position shown in Fig. 2.

The spring pressure of a used spring should be a minimum of 1.6 kg (3.5 lbs) when checked at the position shown in Fig. 2.

If the spring pressure of a new or used spring cell with the spring cell in the brush holder is not within tolerance, remove the spring cell from the

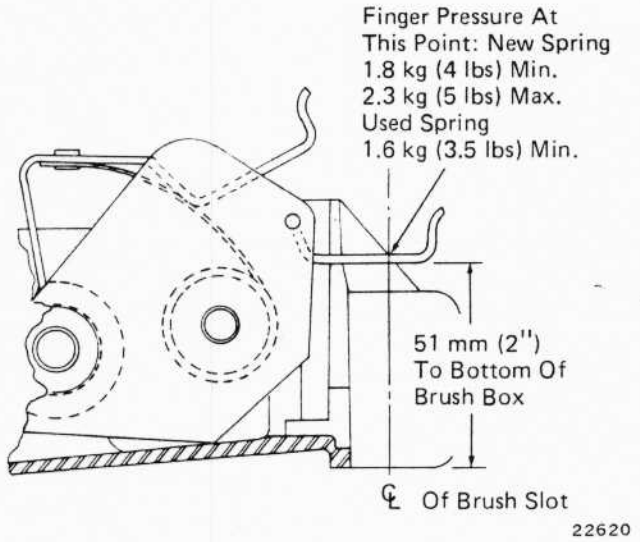

Fig. 2 - Measuring Constant Pressure Brush Holder Finger Pressure (Spring Cell In Place)

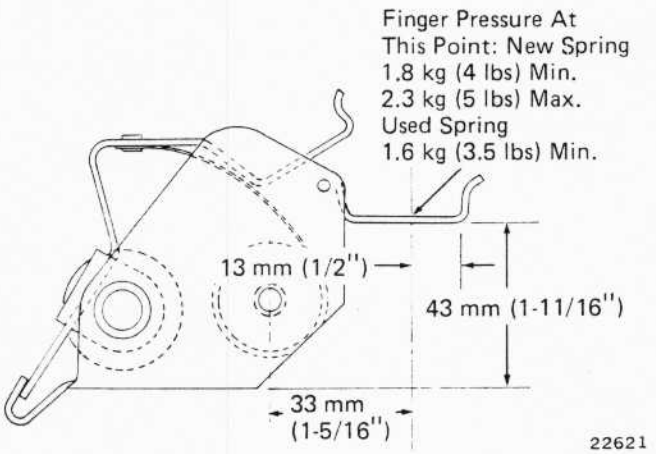

Fig. 3 - Measuring Constant Pressure Brush Holder Finger Pressure (Spring Cell Removed)

brush holder and check as shown in Fig. 3. If the spring is not within tolerance, replace the spring cell with a new spring cell.

COIL SPRING TYPE BRUSH HOLDER

New or replacement brush holder springs for coil spring type brush holders should be set for an initial pressure of 4 to 5 kg (9 to 11 lbs) as measured with a spring tension scale with pressure spring lifted 3 mm (1/8") above the top edge of the brush box as shown in Fig. 4. It is difficult to check brush holder spring pressure accurately with the brush holder in place and it is recommended that the brush holders be removed. Since new brush holder springs lose pressure due to aging in the first few weeks of operation, reset the spring pressure as necessary. After one adjustment, the springs should retain the pressure.

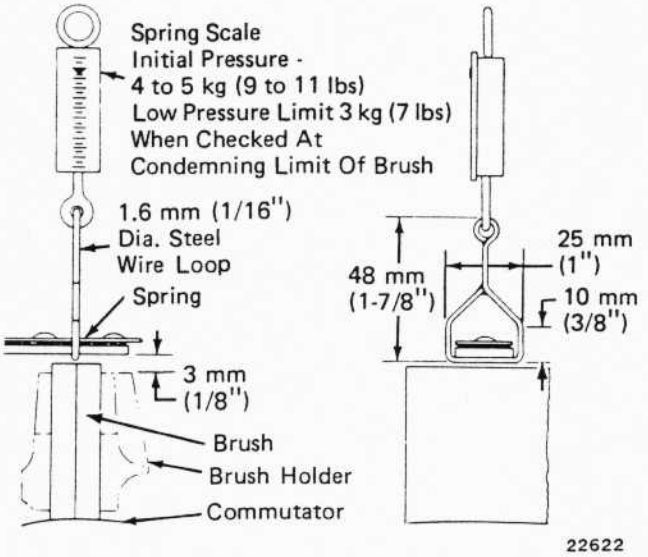

Fig. 4 - Measuring Coil Spring Brush Holder Finger Pressure

The minimum allowable pressure on a completely worn brush is 3 kg (7 lbs). Thus spring pressure should always be set high enough (4 to 5 kg [9 to 11 lbs]) to compensate for loss of pressure that results as the brush wears.

Spring tension can be regulated by removing the cotter pin locking the thimble to spindle and turning the thimble and the spindle. The adjusting collar on the thimble can be set every half notch using alternately two cotter pin holes in the spindle. This will allow a variation of tension from 0.57 to 0.68 kg (1-1/4 to 1-1/2 lbs) for each half notch.

The complete brush holder assembly should be checked to ensure the mounting is secure and the cable and shunt connections are tight. The brush holder should be checked and adjusted if necessary to maintain a dimension of 3 mm to 5 mm (1/8" to 3/16") between the bottom of the carbonway and the commutator surface.

To ensure proper tightness of brush holders and connections, the following dry torque values should be applied;

7/8"-9 brush holder block bolt - 203 to 217 N·m (150 to 160 ft-lbs).

1/2"-13 brush holder cable to brush holder bolt
Model D19 - 95-102 N·m (70-75 ft-lbs)
All Others - 34-54 N·m (25-40 ft-lbs)

5/16"-18 brush holder shunt screw - 15 to 20 N·m (10 to 15 ft-lbs).

BRUSH HOLDER INSULATOR STUDS

Brush holder insulator studs, Fig. 5, should be kept clean and free of defects. The polyester type brush holder studs are unusually resistant to flashover damage. If flashover damage does occur these insulators usually can be restored to satisfactory condition by simply polishing them with fine sandpaper. Polyester glass material should never be subjected to alkaline cleaning solutions.

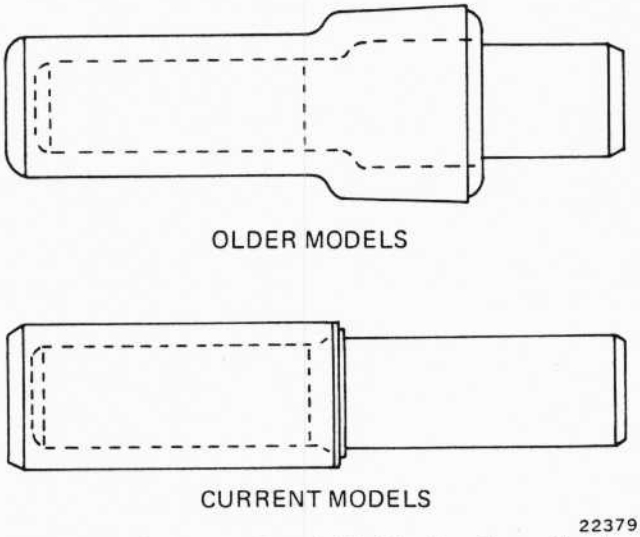

Fig. 5 - Polyester Brush Holder Insulator Stud

NOTE

Early model brush holder insulator studs were insulated with porcelain and should be replaced with the polyester insulated studs. Polyester is more durable and does not become permanently carbon tracked.

Brush holder insulator studs have a silicone rubber insulated sleeve over the base of the studs, Fig. 6. When replacing or reconditioning brush holder assemblies, ensure insulated sleeves are in place.

Replacement polyester glass insulated studs are available in the following sizes:

Standard size - 8159003

To be used in new brush holders or when stud holes are within 25.235 mm ± 0.013 mm (.9935" ± .0005").

0.05 mm (.002") Oversize - 8209068

0.20 mm (.008") Oversize - 8219773

For stud holes which have had a standard size pressed out.

The following studs can be used for extensively scored stud holes which have been reamed out.

0.79 mm (.031") Oversize - 8209069

0.84 mm (.033") Oversize - 8222653

1.57 mm (.062") Oversize - 8222652

1.65 mm (.065") Oversize - 8222654

The oversize studs may be identified by the number 2, 8, 31, 33, 62, or 65 stamped on the bottom of the stud. The number is in reference to the amount oversize in thousandths of an inch. For example, the number 2 identifies the 0.05 mm (.002") oversize stud. The number 65 identifies the 1.65 mm (.065") oversize stud.

INSULATOR STUD INSTALLATION

A sleeve-type tool made of half-hard brass, Fig. 7, should be used for pressing the studs into the brush holder.

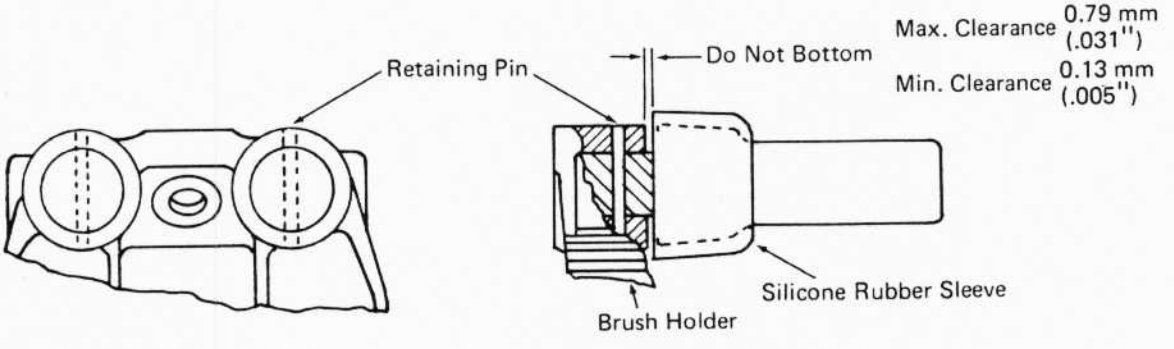

Fig. 6 - Brush Holder Insulator Stud Installation

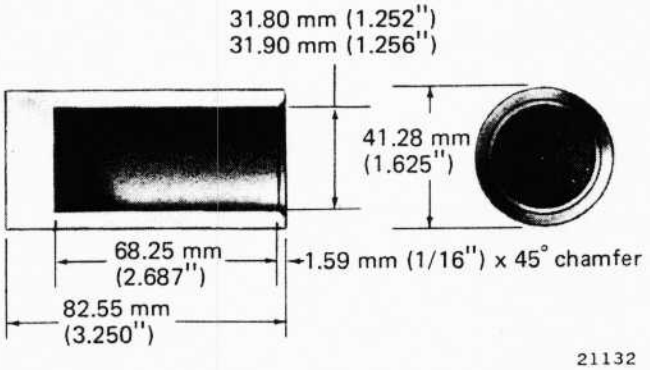

Fig. 7 - Insulator Stud Installation Tool

To replace the brush holder insulator studs, perform the following procedure:

1. Press out brush holder insulator stud, shearing retaining pins.

2. Clean up stud holes of brush holder, if required.

3. Select proper oversize stud. Ensure that 0.05 mm ± 0.025 mm (.002" ± .001") press fit is obtained. Press in stud using sleeve-type tool. Clearance between the stud shoulder and brush holder must be maintained to ensure the insulation does not get damaged against the brush holder.

4. Drill and pin brush holder and stud. Use a No. 23 drill, (.154"), and refer to Service Data for pin part number. Peen over hole on both ends after installing pin.

COMMUTATOR BRUSHES

The commutator brushes should move freely in the brush holder and not be stuck with dirt. This can be checked by lifting the brush pressure spring and raising and lowering the brushes. The constant pressure brush holder springs must be raised by hand and placed in a "cocked" position, but the coil spring brush holder springs may be lifted with the use of a lifter as shown in Fig. 8.

Carbonways must be smooth and brushes must fit closely so they will not chatter. Brush holders with carbonways worn enough to permit brush chatter should be replaced. Carefully lower the brush pressure spring over the brush to avoid snapping which is likely to cause the brush to be chipped.

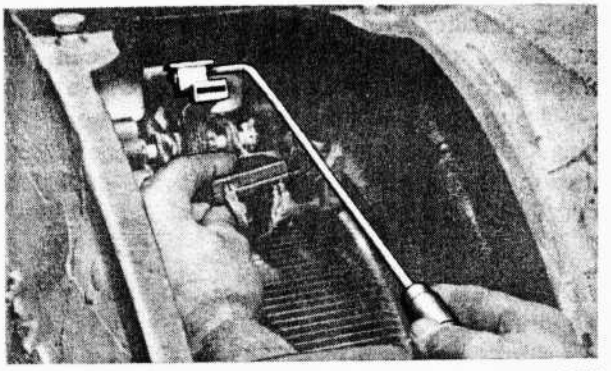

Fig. 8 - Brush Inspection

Brushes should be carefully inspected and replaced if found chipped, broken, or worn to the condemning limit. This brush wear limit is easily determined by measuring the height of the brush pressure spring above the brush holder. If the spring is found to be 3 mm (1/8") from contacting the brush holder as shown in Fig. 9, the brush should be replaced.

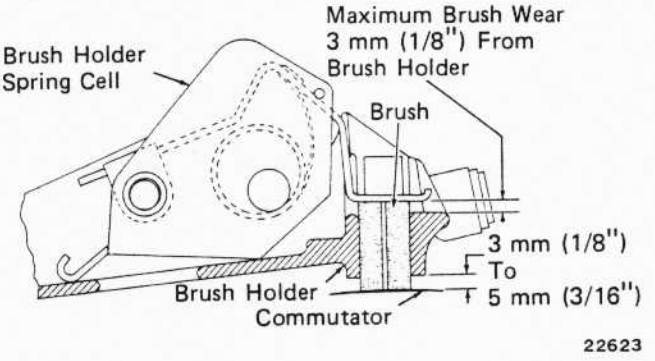

Fig. 9 - Measuring Brush Wear

Brushes may be replaced individually as they wear to their limits, rather than replacing all of them on a motor at one time. Replacement brushes should, however, be of the same type and grade as the ones replaced, since mixing brushes in the same motor can prove to be detrimental to successful operation.

If old brushes are used, they should be installed in the same position in the 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 abrasive side out) around the commutator before the brushes are applied. Install the new brushes and rotate the armature until all the brushes are seated. Refer to Service Data for brush type and part numbers.

If new brushes are 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.

Brush shunts should not be twisted or braided. The shunt connection to the brush holder should be securely made. Brushes should be replaced if found to have broken shunts, or where tamped shunt connection to the brush is loose.

COMMUTATOR

The commutator is a vital area on the traction motor and it should be kept in the best condition possible. Inspections should be made at frequent intervals to ensure detection of surface faults before loss of service or expensive repairs become necessary. Such conditions as film stripping, bar burning, high or low bars, high mica or flat spots tend to become more serious with time. When found, the cause should be determined and corrected as soon as possible.

CREEPAGE SURFACES

The creepage area on units which have the string band area coated with epoxy compound and have TIG welded commutator terminations, should be thoroughly cleaned with alcohol to remove all traces of carbon.

The creepage areas on units which have the string band area coated with red enamel and have soldered commutator terminations, Fig. 10, should be cleaned and recoated with red air drying insulating enamel whenever necessary. The procedure for repainting this surface is as follows:

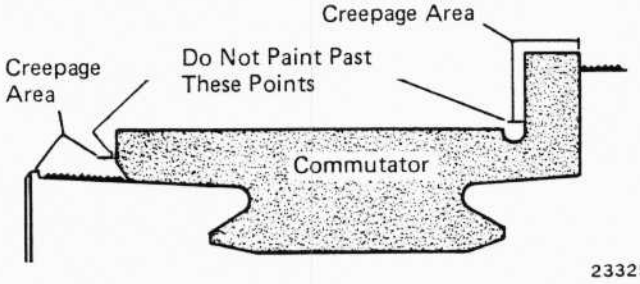

Fig. 10 – Care Of Commutator Creepage Area

1. Clean surfaces thoroughly with alcohol. Remove any trace of carbon.

NOTE

Red enamel can be applied over polyester surfaces if the surface has been damaged.

2. Using a clean brush, apply the red insulating enamel carefully to the creepage surfaces. Make as thin a coat as possible applying the enamel evenly leaving no dabs or overlapping areas.

   The enamel will generally be of the proper consistency if the cover on the container has been kept tight. If thinning is necessary, use mineral spirits sparingly.

3. Take care to avoid getting enamel into commutator slots or the relief at the bottom of the commutator neck.

4. Wait until enamel is dry before running motor.

NOTE

Do not apply enamel over carbonized or charred insulation. If the insulation cannot be cleaned up satisfactorily as outlined above, the motor should be removed for more permanent repairs.

COMMUTATOR SURFACE CONDITIONS

Frayed brush shunts, highly polished brush to brush box contact surfaces, excessively worn brush pressure arms, broken pressure springs, and rapid brush wear are indications of more than normal brush movement within the brush box and the cause should be determined. With few exceptions, the cause will be found to be commutator surface irregularities. The constant monitoring of the brush problems mentioned above is the best and easiest method of determining when a commutator should be ground.

Road seasoning (repeated heating and cooling of the commutator), standstill burns, and overspeed can cause some slight bar movement to occur. This bar movement, depending on the amount, the number, and location with respect to each other, could trigger conditions detrimental to both the commutator and brushes. A commutator having certain irregularities in profile could operate satisfactorily at lower locomotive speeds, however, when operated at higher locomotive speeds, the problems of flashover, brush breakage, and frayed brush shunts may develop. A very rough commutator would have these same conditions occurring at lower locomotive speeds.

A rough commutator may or may not be readily apparent to the eye. Any question as to the condition of the surface can be answered with the use of a dial indicator attached to the motor so the plunger rides on the commutator surface. Be sure indicator is on one of the brush tracks. Rotate the armature slowly and carefully observe the readings. By merely noting the minimum and maximum readings, a true picture of the commutator surface will not be obtained. The 0.08 mm (.003") runout tolerance (for new or rebuild motors) is not applicable as a measurement of commutator irregularity as the problem of irregularity is not one of machining tolerances but of bar to bar movement. An example of this would be to have readings around the commutator that give a total variation of 0.05 mm (.002"), however, hidden within the 0.05 mm (.002") variation are six low areas, each spanning one or more bars. This commutator would cause the brushes to bounce with resultant damage. A commutator having a total variation of 0.10 mm (.004") with the minimum and maximum readings 180° apart is an acceptable commutator whereas the first example, 0.05 mm (.002") variation with several low areas, is not acceptable even though the total variation is much less. It is difficult to give a number value which would determine when a commutator should be ground. The values obtained by dial indicator must be evaluated with respect to the performance of the motor (brush problems, flashovers, etc.) and a certain amount of personal judgement must be used. A useful rule of thumb is that any condition worse than 0.05 mm (.002") in a six (6) bar span calls for grinding the commutator.

Resurfacing the commutator by turning in a lathe, or use of a grinder and grinder adapter, is the only correction recommended for a rough commutator. Hand stoning is definitely not recommended.

COMMUTATOR GRINDER MAINTENANCE

In order to produce an acceptable commutator surface finish, it is imperative that the jig stoning fixture be maintained in good condition. The use of a poorly maintained or incorrectly adjusted grinder will result in perpetuating the surface irregularities. Refer to Fig. 11 and check the grinder as follows:

There can be no abnormal movement, however slight, between the grinder cross-slide and the

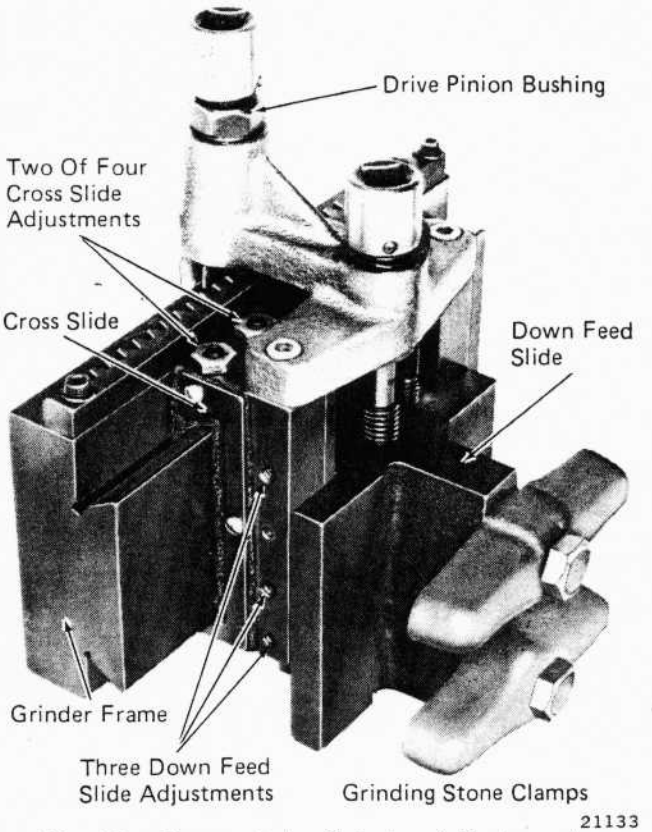

Fig. 11 - Commutator Grinder Adjustments

grinder frame or between the down-feed slide and the cross-slide. The movement can be detected by placing a fingertip on the parting of the two pieces and attempting to move either one of the pieces in all directions other than the normal direction of travel.

The travel of the cross-slide should be smooth with no binding, jerking, or tightness during the full travel from end to end. Any binding or tightness in the cross-slide travel is usually the result of one or more of the four Allen screws being incorrectly adjusted. Jerky movement of the cross-slide travel is usually the result of either grinding dust trapped between the two sliding surfaces or an incorrectly adjusted or loose bushing on the pinion shaft.

The grinder must be periodically cleaned and adjusted. The frequency of the cleaning is determined by the use of the grinder and should be performed before there is any binding or jerky movement of the cross-slide.

Do not attempt to clean an assembled grinder by dipping in a solvent or by using air pressure to blow out dust. The grinder must be completely disassembled to clean.

COMMUTATOR GRINDING

Commutator surface irregularities such as etching, roughness, or slight burning can often be corrected by resurfacing, using a grinding fixture and an adapter.

NOTE

In order to produce an acceptable commutator surface finish, it is imperative that the jig stone fixture be maintained in good condition. The in-feed and cross-feed gib ways must be clean and free from burrs so the device feeds smoothly. The gib keys must be adjusted so that no free play exists in the sliding assemblies, but not so tight to cause binding. Refer to Commutator Grinder Maintenance Section prior to grinding the commutator.

This grinding can be done on a motor in a truck while under the locomotive by using the following method:

1. Block all wheels on truck at opposite end of locomotive to one having traction motor commutator ground.

2. If the axle of the wheel set driven by the motor having its commutator ground is equipped with roller journal boxes, proceed as follows to raise the desired wheel set:

   a. Apply suitable wooden or steel blocks under the two journal boxes between the pedestal tie bar and the journal box on the wheel set to be raised. These blocks will hold the axle in its original position and eliminate unnecessary raising when the motor is being run. Next apply jacks under the locomotive frame at jacking pads provided and raise one end of the locomotive with truck so the desired wheels are just above the rails.

   b. An alternate method of raising a pair of wheels is to remove the weight of the locomotive from the truck with jacks, then raise the desired wheel set by placing jacks directly under the journal boxes.

3. If the axle of the wheel set driven by the motor having its commutator ground is equipped with friction type journal boxes proceed as follows to raise the desired wheel set:

   a. Apply suitable wooden or steel blocks under the two journal boxes between the pedestal tie bar and journal box on the wheel set to be raised. Then apply jacks under the locomotive frame at jacking pads provided and raise one end of the locomotive with truck so that the desired wheels are just above the rails. Next jack CAREFULLY under traction motor axle bearings until they take the weight of the axle and wheels only. Block all raised parts with exception of wheel set being worked on.

GRINDER ADAPTER INSTALLATION

1. Remove the bolt securing the brush holder cable to the top brush holder. Remove the bolt securing the top brush holder clamp block and remove brush holder.

2. Tape the copper lug of the lead which was disconnected from the brush holder so it will not short against motor frame.

3. Install the adapter in the top brush holder position and secure it with the brush holder clamp block and bolt as shown in Fig. 12. Refer to Service Data for grinder adapter part number.

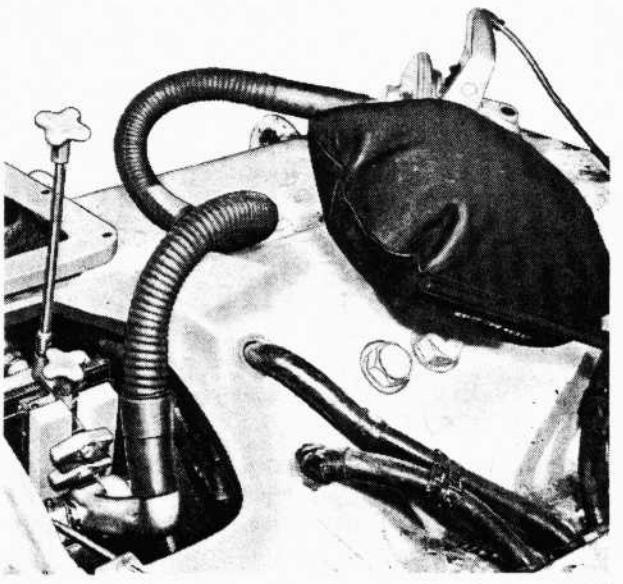

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Fig. 12 - Grinder Installation

GRINDER INSTALLATION

1. Install alignment bar on the grinder down feed slide. Check the alignment bar contact to

the feed slide for zero clearance with a thickness gauge. Refer to Fig. 13. Any clearance at either side of the alignment bar contact surface indicates the bar is not parallel to the grinder. Refer to Service Data for alignment bar and grinder part numbers.

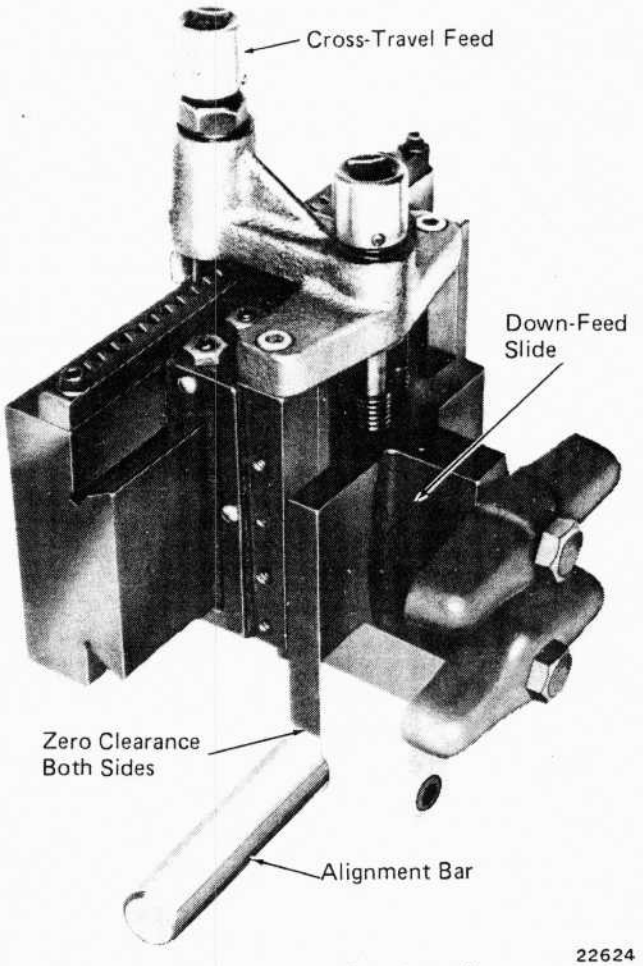

Fig. 13 - Commutator Grinder Alignment Bar Installation

2. Install the grinder with the alignment bar on the adapter as shown in Fig. 12.

3. Position the motor armature so that the alignment bar will contact approximate center of the commutator bar. Parallel the alignment bar to the commutator surface using the small areas outside of the brush track at both ends of the commutator bar. The alignment bar should be within 0.08 mm (.003") of paralleling the commutator bar.

4. Remove the alignment bar from the grinder and install two grinding stones. Use finish grade stones. Mount the stones so that they are seated squarely on the commutator. Pull stones away from the commutator using the grinder cross-travel feed.

GRINDING

The supply voltage to the traction motor can be a DC welding machine (or other source of DC electrical energy). The desired motor RPM for the grinding operation is approximately 1500 RPM. A satisfactory surface finish can be obtained at a reduced RPM, but the grinding time will be lengthened. Do not use a speed below 1000 RPM.

NOTE

Commutator can be ground by utilizing locomotive power. Contact EMD Service Department for details.

1. Disconnect all four traction motor leads of the motor to be worked on, and tag the leads so they can be reconnected in their original position. Connect the motor leads to rotate the armature in a clockwise direction as viewed from the commutator end. Incorrect rotation (counterclockwise) could cause the grinding stones to chatter on the commutator. Connect the traction motor leads as follows:

   Connect the positive supply lead to the "AA" lead of the motor.

   Connect the "A" and the "F" leads of the motor together.

   Connect the negative supply lead to the "FF" lead of the motor.

NOTE

Brushes that are used in the motor for grinding operation will have particles of grinding stone, dust, and copper imbedded in the surface that rides on the commutator. These particles can cause rapid deterioriation of the commutator surface if the contaminated brushes are not removed from the motor. It is recommended that if the brushes in a motor are of sufficient length to continue service after the commutator is ground, they should be removed from the motor before grinding is begun and then reinstalled after completion of the operation. Ensure brushes are marked so that they can be reinstalled in their original position. Brushes that are near the condemning limit for length should be used in the motor for the grinding operation.

2. Start the motor and feed the grinding stones into the commutator slowly, using the down-feed handle until light contact is made. Proceed to grind the commutator by feeding the stones not more than 1/8 turn of the down-feed handle (45°) and move the stones across the commutator at a moderate speed for three complete passes. One pass being the movement across the commutator in either direction. Upon completion of the third pass, the stones can be fed down another 1/8 turn of the down-feed handle. Alternating the end of the commutator from which the stones are fed down will minimize the possibility of the development of a taper across the commutator. Continue this procedure until all low areas have been completely eliminated.

NOTE

Feeding the grinding stones down more than 1/8 turn of the down-feed handle will result in very rapid wear of the grinding stones and also cause copper rollover on the trailing edge of the commutator bar. The copper rollover will have to be removed with the use of a de-burring tool. The recommended light feed will result in very small copper slivers on the trailing edge of the commutator bar which can easily be removed with a wire brush.

3. Remove the stones from the grinder and place them in their original box so that they will not become contaminated with oil or dirt. Remove the grinder and adapter.

4. With the armature rotating, clean the outer end of the commutator bars with a small piece of grinding stone.

5. Remove and discard the brushes used in grinding operation.

6. Thoroughly clean the motor to remove all copper and grinding dust by directing clean, dry compressed air at moderate pressure on the face of the commutator. Blow out brush holders, stator windings, and end housing. Rotate the armature by hand when blowing out commutator slots.

7. Remove the slivers of copper on the trailing edge of the commutator bar with a clean wire brush. Position the brush close to the commutator riser with the wire bristles toward the riser face and roll the wire bristles down toward the commutator slot until they enter the slot. Move the brush across the commutator until the wire bristles have cleared the end of the commutator slots. While moving the brush across the commutator, apply moderate pressure in towards the commutator as well as pressure towards the trailing edge of the commutator bar. This procedure will remove all copper slivers on the bar and in the slots without damaging the commutator surface.

NOTE

The scratch marks will disappear when the soft grade of chalk stone is used to finish the seating of the brushes.

8. When the depth of the mica undercut between copper bars is less than 1.2 mm (3/64"), use commutator slot file, Fig. 14, to undercut the mica to proper depth. Do not exceed the undercut maximum depth of 2 mm (5/64").

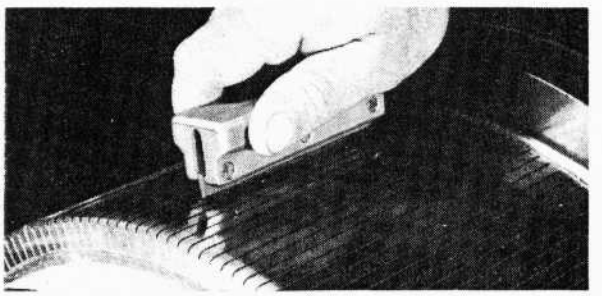

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Fig. 14 – Cleaning Commutator Slots

9. Use chalk stone for final clean up of commutator. Do not use emery cloth or sandpaper for this purpose. Lubricant should never be used on commutators, as brushes have enough graphite to supply their own lubrication.

10. Rotate armature by hand and blow clean dry air into the commutator slots to remove any loose pieces of copper. Wipe dirt and copper dust away with clean cloths. Carefully inspect cleaning job and particularly the slots between commutator bars to see that all traces of undesired copper have been removed.

11. Replace brush holder assemblies and brushes. Install either new or the used brushes, but do not use any brush that had been left in the brush holder during the grinding operation. Reconnect cables.

12. Reconnect cables and install inspection cover. Check motor for proper rotation before returning locomotive to service.

NOTE

If the commutator has been damaged to such an extent that the grinding process proves ineffective, the motor will have to be removed and the commutator turned in a lathe.

ARMATURE BEARINGS

NOISE TEST

Each time a traction motor is removed from a locomotive truck it should be operated so that a noise check can be made for faulty armature bearings. Performing this test will serve as a means of detecting faulty bearings thus preventing such a motor from operating in service where it would likely result in a road failure.

The power source and cable connections for this test are the same as described previously for rotating the armature during commutator grinding. The armature speed should be brought up to about 1500 RPM and then the power shut off to allow the armature to coast to a standstill. Carefully listen and try to determine the source of any noise that might be considered unusual. Experience and comparison with other motors will help distinguish a faulty bearing from a normal one.

SEALED GREASE LUBRICATED BEARINGS

Unless otherwise specified by the customer, all traction motors are manufactured with sealed grease lubricated armature bearings. A specific type of grease is used. The amount and method by which it is applied is carefully controlled.

Refer to recommended maintenance intervals specified in the applicable Scheduled Maintenance Program. For information on repacking these bearings refer to Section 7 of Maintenance Instruction M.I. 3952.

NOTE

Model D19 motors were equipped with a non-sealed grease bearing which requires periodically adding grease. Refer to Section 2 of Maintenance Instruction M.I. 3952.

GEAR CASE AND GEARS

The gear case houses the traction motor pinion and mating axle gear, protecting them from dirt or damage and carries the gear lubricant. The cases are made of two close fitting halves and feature offset seals to provide complete contact and closure. Removable gutters over each seal retainer, and grease deflectors, divert the flow of grease away from seal surfaces.

The inspection opening and grease filler cap is located on the lower half of the gear case. This makes it convenient for inspecting gears, checking lubricant, and adding lubricant.

The caps are sealed by mating machined surfaces without the need of gaskets. A leaf spring assembled to the top of the filler cap maintains pressure against the flanges around the gear case filler opening, assuring a positive sealing action. The filler caps may be easily removed or applied by depressing the leaf spring, using tool as shown in Fig. 15.

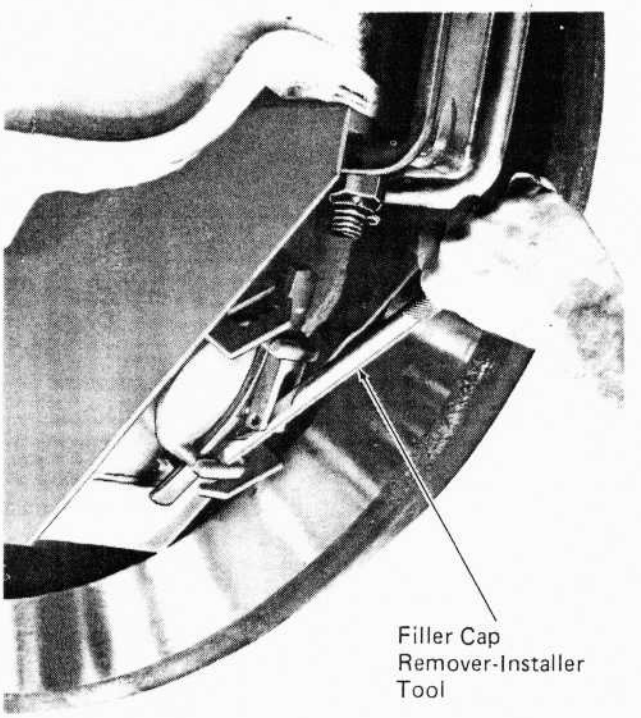

Fig. 15 - Gear Case Filling Cap Removal Tool

The current gear case also features unit type felt seals inserted into the channels at the axle and pinion openings. The seals are held in place by small pieces of metal at one end of the channels next to the inside of the case and are designed to prevent the seal from turning. This will tend to prevent the excessive loss of lubricant that occurred when the previous type felt seals would move in the channels due to the turning forces inposed on them.

LUBRICATION

Inspection of gear cases should include checking for lubricant leaks. Excess lubricant will be discharged through the drain slot of the traction motor grease seal during the first few thousand miles of operation and is no cause for concern. Prolonged leakage at any other point, however, should be corrected.

Gear lubricant level should be maintained to near the lower edge of the inspection and grease filler hole.

Refer to the applicable Scheduled Maintenance Program for the recommended interval of gear case inspection and the type of lubricant to be used. Frequent gear case grease level inspections should be made using such intervals as a guide until the maximum mileage between lubrication intervals can be determined for the specific type of service encountered.

The need for lubricant can be readily determined by observing the condition of the gear teeth through the gear case inspection opening. Gear teeth appearing dry or having bright spots indicate that grease should be added. Gear lubricant should be maintained at sufficient depth to allow the full tooth to dip into grease. Add 0.9 kg (2 lbs) of recommended lubricant when such inspections indicate the need.

Measurements of lubricant level should be made after a locomotive comes in from a run and is allowed to stand without moving for at least one-half hour. This will allow time for the grease to drain to the bottom of the case and cool.

GEAR CASE INSPECTION WHEN REMOVED

After removal, thoroughly clean gear case of all dirt and grease by immersing in hot water solution of caustic. Never remove grease by burning as this may distort the gear case to the extent that it will not fit properly when installed and grease leakage will occur. When clean and dry, repaint gear case using buff primer.

Felt seals should always be replaced whenever a gear case is removed as failure to do so may result in serious lubricant loss while in operation and possible damage to the gears. The seal change procedure is as follows:

1. Remove and discard old seals and apply complete new unit seal assembly. There is no need to clean out channels or apply cement to new seals.

2. Check to make sure the drain slot between seals is open to ensure against contamination of support bearing oil with gear lubricant. Grease entering the support bearing would clog and glaze the lubricator wick making it inoperative.

3. Apply a generous quantity of lubricating oil to the felt seals.

4. Assemble the gear case to the truck assembly making sure the bolts and safety straps are properly applied and secured. Lubricate bolts with Texaco Threadtex and torque to 576 to 610 N·m (425 to 450 ft-lbs). Failure to properly tighten the bolts will result in excess wear due to vibration on the supporting arms located on the axle cap and pinion end bearing housing.

5. Charge gear case with 3.6 kg (8 lbs) of recommended lubricant. It is important that the recommended lubricant (see Maintenance Instruction M.I. 1756) be used, since substitutes may have poor oxidation stability and tend to solidify in extended service.

6. After an initial trip, check gear case condition and lubricant level adding a 0.9 kg (2 lb) quantity if required. Thereafter, inspections should be made at intervals specified in the applicable Scheduled Maintenance Program.

MOTOR SUPPORT BEARINGS

The traction motor has three suspension points in the truck. Two are provided by the support bearings which connect one side of the traction motor to the wheel axle. The third point is provided by two lugs on the motor frame that contact the top and bottom of the nose support assembly on the truck frame. This nose suspension thus arrests the upward or downward movement of the motor depending on direction of rotation when power is supplied.

The support bearings are of the split type and "hour glass" design. A half of each bearing assembly is inserted in the motor frame while the mating half is installed in the support bearing cap. Both halves are machined together and are identified by a serial number. The bearings are thus matched and must be kept together and installed in sets. The commutator end and pinion end bearing assemblies are interchangeable.

SUPPORT BEARING LUBRICATION

Lubrication of traction motor support bearings is provided by a felt wick inserted in the oil reservoir in each bearing cap. A spring loading arrangement keeps the wicks firmly in contact with the wheel axle through an opening in the bearing.

The oil level in the support bearing cap should be checked at intervals specified in the applicable Scheduled Maintenance Program. The level is determined by inserting a clean steel rule or rod properly marked, into the oil filler hole. Accurate measurements can be obtained only if the rule or rod is inserted parallel to the pipe as shown in Fig. 16. Refer to Service Data for lubricating oil level. Add as required to maintain proper level.

A narrow window traction motor axle cap and support bearing arrangement is used on current model motors. The narrow window provides increased oil capacity and larger bearing surface as well as an improved wick lubricator, Fig. 18.

Refer to Maintenance Instruction M.I. 1756 for recommendations on the type of lubricating oil specified for support bearings, adding as needed to maintain desired level.

If inspection shows that water is present in the oil reservoir, it should be drained before the unit is returned to service. The wick should also be removed and inspected. See Item No. 7 under Felt Wick Lubricators. Replace unsatisfactory wicks.

FELT WICK LUBRICATORS

Felt wick lubricators should be carefully inspected at wheel turning time, or more frequently if service dictates. Cleaned and re-qualified wicks should be installed as directed by applicable Scheduled Maintenance Program, preferably prior to the winter season.

Cleaning is accomplished by soaking the wicks in oil heated to 49° C to 60° C (120° F to 140° F). The contact surface of the wick may be cleaned by rubbing with an oil soaked rag. Light sludge may be removed by gently brushing with a soft bristle brush followed by rubbing with oil soaked rag as above. Refer to Maintenance Instruction M.I. 1756 for correct type of oil.

Use of wire brush can cause wick damage, and is therefore not recommended. If solvents are used, the wick must be dried and then thoroughly soaked in oil so that no solvent remains to dilute the oil.

After cleaning, the felt wick assemblies should be inspected to determine if they are in satisfactory condition for continued service. The following points should be observed:

1. Wicks should be discarded if they have hardened, glazed, burned, or have excessive taper wear on the contact surfaces.

   Packing or glazing may be checked by squeezing the edges of the contact face with the fingers to cause oil to pool on the face. If oil does not quickly drain back into wick it should be discarded.

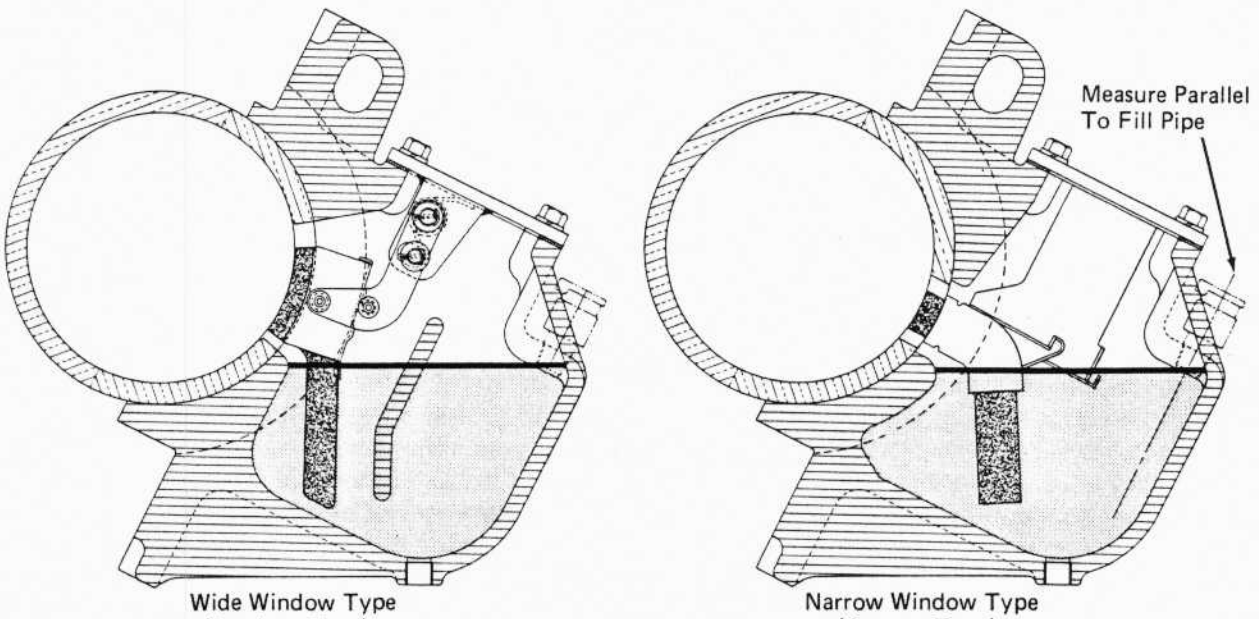

Fig. 16 – Motor Support Bearing Oil Level

2. The wick contact surfaces should be free of irregularities. Slight depressions are permissable if they do not extend for the full length of the wick.

3. Visually inspect the metal wick carrier assembly for warping, distortion or cracks which are causes for rejection. Check pinholes and pins for wear and replace parts if worn more than 0.30 mm (.012") over new assembly.

4. Check wide window support bearing lubricator spring pressure by placing a weight on the wick assembly as shown in Fig. 17. Use a 3 kg (7 lb) weight for new assemblies and a 2 kg (5 lb) weight for used assemblies. The tail of the wick should not touch the work bench when the weight is applied. Ensure the wick is positioned so that the front edge of the slot in the top of the wick is against the positioning pin in the carrier. Check the support bearing lubricator assembly with a 4 kg (8 lb) weight. The wick must move when the 4 kg (8 lb) weight is applied.

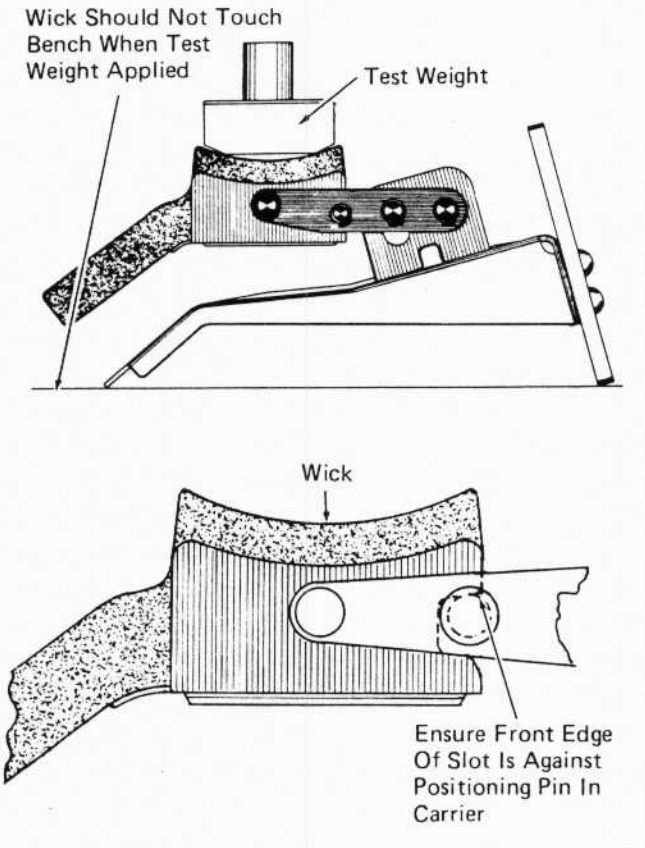

Fig. 17 - Testing Wide Window Wick Lubricator Springs

Check narrow window support bearing lubricator spring pressure by placing a weight on the wick assembly as shown in Fig. 18. The check should be made with the wick saturated with oil and all sliding parts clean and lubricated. The support bearing lubricator spring should be able to raise a 0.9 kg (2 lb) weight placed on the contact surface after the wick is depressed.

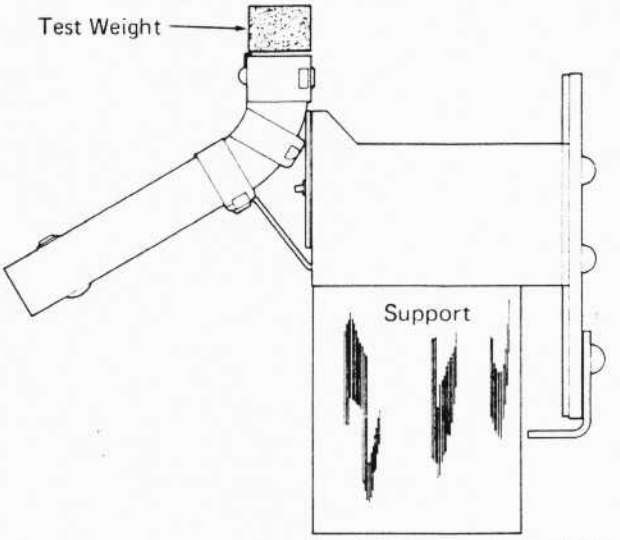

Fig. 18 - Testing Narrow Window Wick Lubricator Spring

5. All early style flat or constant-pressure-type narrow window support bearing wick lubricator springs should be inspected for cracks near rivet point. If any defective or cracked springs are found, the assembly should be replaced with a wick conversion kit. Refer to Service Data for part number.

6. New and used wicks must be impregnated with oil prior to use. Refer to Maintenance Instruction M.I. 1756. Impregnate wicks as follows:

   a. Soak wicks for a minimum of 20 minutes in oil at room temperature or 10 minutes in oil heated to 71° C (160° F). Wicks should not be allowed to touch bottom of container when soaking in heated tank.

   b. Allow to drain for 10 minutes to facilitate handling and installation. Use care to keep wicks clean while handling.

7. If there is evidence that water has been absorbed into the wick, remove moisture as follows:

a. Submerge wicks in oil heated to 104° C (220° F) for 8 hours.

b. Allow to cool, while still submerged, until oil cools to room temperature.

c. Remove wick from tank and allow to drain for 24 hours before use.

SUPPORT BEARING WEAR LIMITS

The support bearings should be checked for lateral clearance to make sure they do not exceed the wear limits shown in Fig. 19.

Radial bearing to axle clearance is measured by removing the felt wick lubricator and inserting a narrow feeler gauge between the unloaded area of the bearing and the axle.

The bearings should be replaced in sets when the wear limits are reached.

REMOVING MOTOR SUPPORT BEARINGS

1. Run the locomotive over a pit.

2. If the bearing to be removed is on the gear side, it will be necessary to remove the gear case safety straps and drop the lower half of the gear case.

3. If the bearing to be removed is on the commutator end, remove the dust guard (both halves).

4. Drain the axle cap lubricating oil.

WARNING

When removing the bearing cap, ensure cap is supported by crane or properly blocked. When bolts are removed, the cap may drop suddenly, causing personal injury.

5. Take out the four support bearing cap bolts.

6. Remove the support bearing cap. If the cap sticks, it can be loosened by tapping the cap.

7. Remove the axle shield and the lower half of the support bearing.

8. To remove the upper half of the bearing, jack the motor frame high enough to relieve the weight on the bearing and to free it from the key. Then revolve the upper half around axle until it can be slipped off. If bearing sticks in the frame, it can be knocked loose by driving down on the flange with a hammer and wooden block.

SUPPORT BEARING INSPECTION

Bearing shells should be carefully inspected and replaced or returned to service depending on the following conditions.

1. Do not reuse bearing in which:

   a. The wear pattern extends beyond the window.

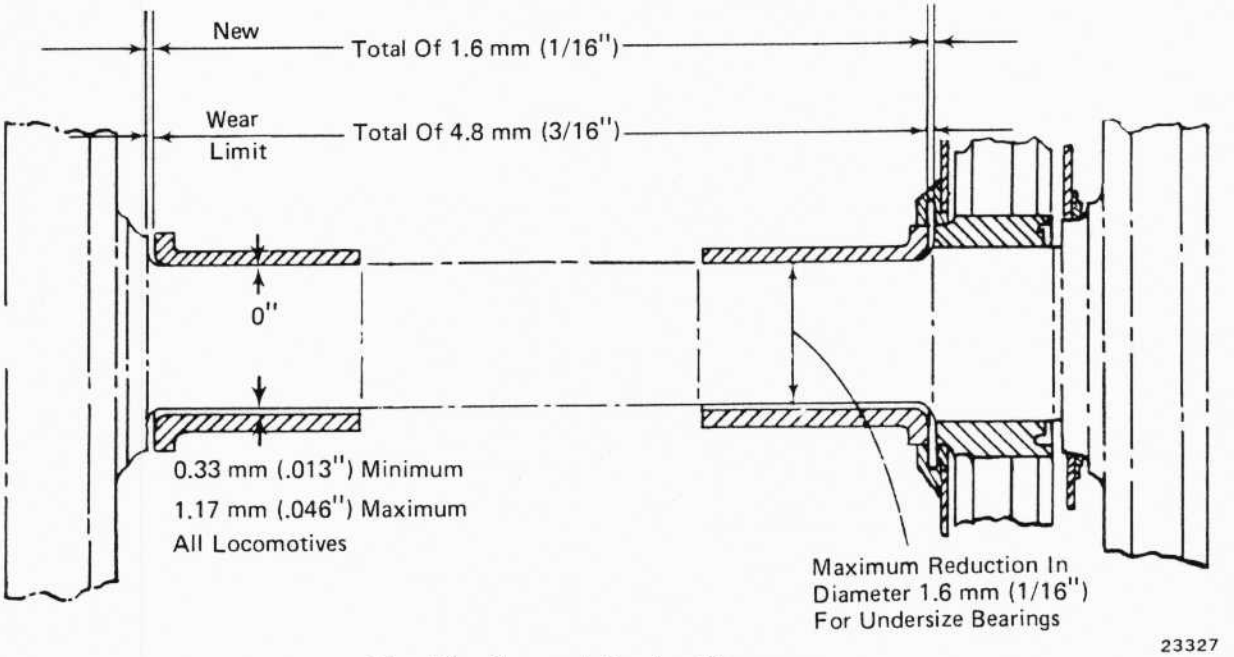

Fig. 19 – Support Bearing Clearance

b. The assembled diametral clearance exceeds 1.2 mm (.046").

c. The assembled lateral clearance exceeds 5 mm (3/16").

d. There is evidence of babbitt shelling, overheating, or fatigue cracks.

2. Remove foreign particles imbedded in the babbitt.

3. Check condition of flange lubricators. If flange lubricators are worn, contaminated, or damaged, replace with new lubricators.

4. Reused bearings should be free of nicks and scratches. Scrape local areas lightly with a flat scraper and polish with fine abrasive coated screen or crocus cloth.

5. Select the best quality bearings for use at the pinion end since it is most heavily loaded.

Before replacing bearings that show signs of having been overheated, the cause should be determined and corrected. The following points should be checked:

1. Insufficient lubricating oil in the support bearing cap.

2. Use of improper or contaminated lubricating oil.

3. Insufficient bearing clearance.

4. Misalignment of bearing shells.

5. Dirt or other foreign substances working into the bearing.

6. Wick lubricator surface fouled with dirt, or glazed.

7. Damaged or improperly operating wick lubricator assembly.

In the event that the bearing has run extremely hot, it is likely that the axle bores have been distorted and the traction motor heated sufficiently to cause damage to the frame, bearings, and field windings. Suspicion of any of these items having occurred will necessitate removal of the motor for thorough inspection. Particular attention should be paid the motor armature bearings as the heat may have dissipated the grease. Traction motor removal is covered later in this bulletin as is the use of a mandrel for checking axle bore alignment.

REPLACEMENT SUPPORT BEARINGS

To accommodate worn or undersize axles, motor support bearings are available with 0.8 mm, and 1.6 mm (1/32", 1/16") undersize bores. These bearings have standard size flanges. Bearings are also available with standard bores and 0.8 mm (1/32") oversize flange thickness which may be used to keep within the lateral measurements specified in this bulletin. To prevent inadvertently applying such bearings, the flanges are stamped with the oversize designation and painted red. An oversize bearing flange may be used on one axle with a standard or another oversize bearing flange in order to obtain the proper lateral dimension. Refer to Fig. 20 for available support bearings.

D19, D29, D31, D36 – 203 mm (8") Lined

Part No.	Bore	Flange
8435108	Standard	Standard
8435109	0.8 mm (1/32") Undersize	Standard
8435110	1.6 mm (1/16") Undersize	Standard
8435111	Standard	0.8 mm (1/32") Oversize

D29CC, D29CCBT, D29CC-7 – 165 mm (6-1/2") Lined

Part No.	Bore	Flange
8347064	Standard	Standard
8347065	0.8 mm (1/32") Undersize	Standard
8347066	1.6 mm (1/16") Undersize	Standard
8347067	Standard	0.8 mm (1/32") Oversize

Fig. 20 - Wick Lubricated Flange, Support Bearing

SUPPORT BEARING CAPS

The support bearing caps are machined and line bored to size when mounted on the traction motor with a 0.20 mm (.008") shim inserted between the cap and motor frame. When the motor is mounted in a truck, the shim is removed giving a 0.20 mm (.008") clamp fit or squeeze to the axle bearing shells.

Line boring of the caps to the motor frame is necessary to secure the accuracy of bearing fit required. The caps are not interchangeable with each other on a given motor or with caps of other motors. To ensure that they are matched to the proper motor and location, they are stamped with a serial number matching the motor frame number.

Support bearing caps that have been removed should be thoroughly washed in a suitable solvent. After cleaning and drying, the cap may be tested for leaks by painting the outside with chalk dust mixed with water. When dry, fill with kerosene and allow to stand for one hour, then observe for leaks.

INSTALLING MOTOR SUPPORT BEARINGS

1. Make certain all parts are clean, particularly the bearing shells, seats, axles, and caps.

2. Check bearing serial numbers, as they must be installed in matched sets.

3. Apply recommended lubricating oil on the inside diameter of bearing shells. Bearing shell flanges should contact their mating surfaces on the motor frame to prevent possible lateral movement.

4. Ensure proper motor support bearing cap bolt and washer combination is 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.

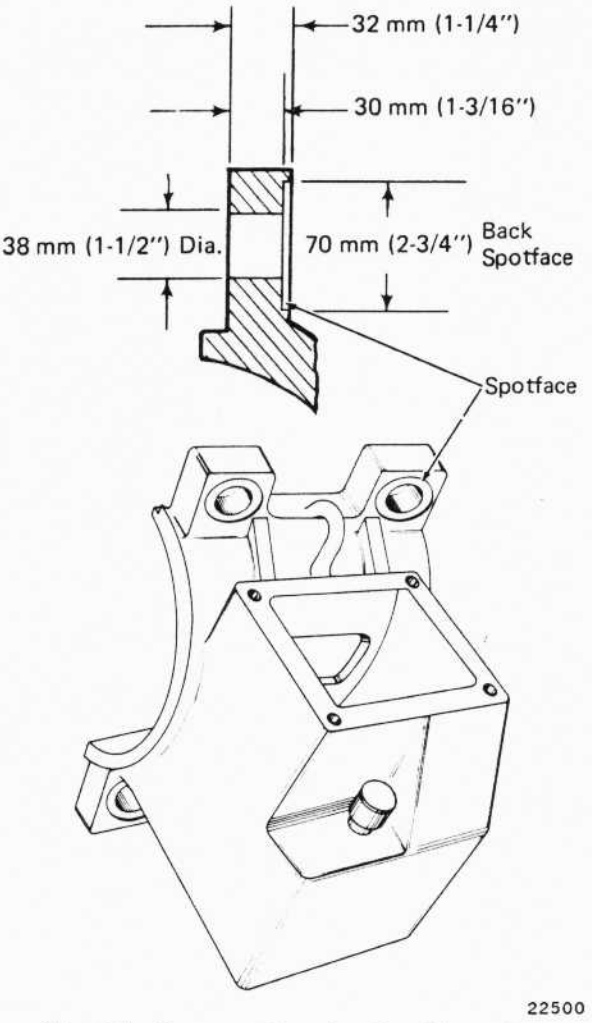

Fig. 21 – Support Bearing Cap Mounting Spot Face Remachining

If the mounting spot face on the axle is galled, the spot face should be welded and machined to the dimensions of Fig. 21.

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

5. The serial number on the support bearing cap and motor frame should correspond and the cap face must line up properly with the motor frame. Apply axle shield, apply cap straight as rocking will distort splines and pinch the bearings. After proper washers are installed, lubricate threads and under bolt heads with Texaco Threadtex. On D29CC motors, tighten bolts to 576-644 N·m (425-475 ft-lbs). On all other motors, tighten bolts to 1491-1627 N·m (1100-1200 ft-lbs). Ensure cap is not cocked in the motor frame. Lockwire adjacent pairs of bolts.

6. Measure lateral and radial clearance as shown in Fig. 19.

   To measure radial clearance, position traction motor with nose suspension sufficiently downward to place support bearing window at top dead center position. Insert narrow feeler gauge to a depth of 25 mm to 51 mm (1" to 2") between the center of one of the longer edges of the support bearing window and the axle.

7. Apply the previously soaked felt wick lubricator assemblies. Pour oil over felt wicks, filling reservoir to proper level with recommended lubricating oil per Maintenance Instruction M.I. 1756.

8. Install gear case and axle dust guard.

CHECKING SUPPORT BEARING ALIGNMENT

To check support bearing alignment, use new standard size support bearings. Install the proper support bearing caps and tighten bolts snugly. Apply the mandrel through both axle caps (wicks removed) as shown in Fig. 22 and rotate it by hand. Misalignment will be indicated if the mandrel binds and does not turn freely. The cause should be determined and corrected before placing such a motor in service. Refer to Service Data for file number of mandrel which can be manufactured for checking alignment. The drawing is available from EMD Service Department (at no charge) and includes construction details to manufacture the mandrel.

DUST GUARD

A dust guard, Fig. 23, is installed over the commutator end axle bearing flange and the wheel hub to keep dirt and grit out of the support bearing.

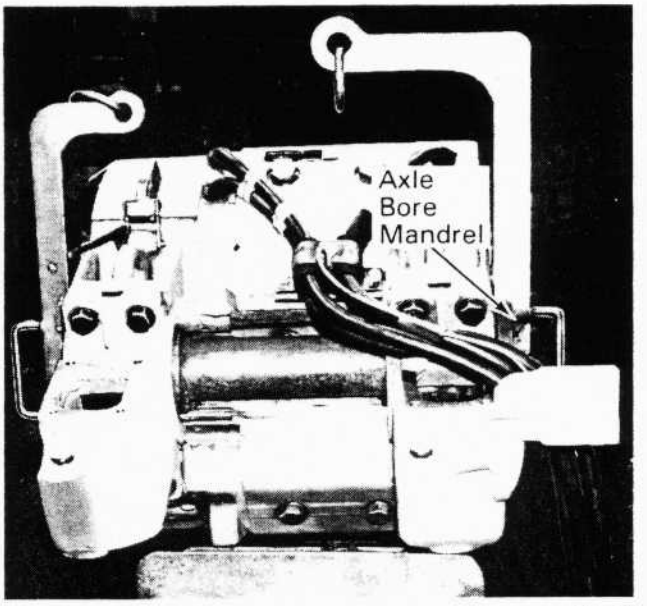

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Fig. 22 - Application Of Mandrel

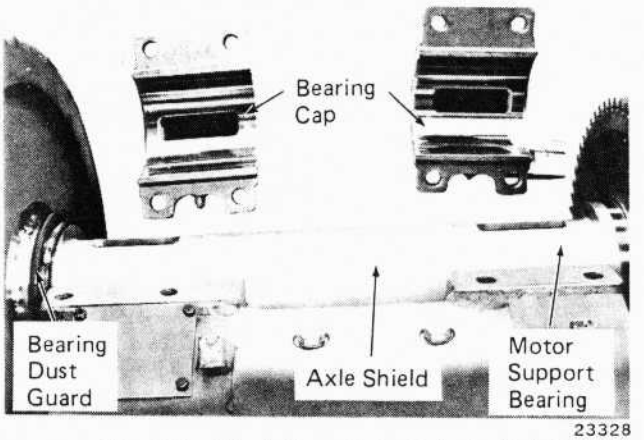

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Fig. 23 - Dust Guard And Axle Shield

Model D19

If aluminum or cast iron dust guards are to be reused, apply felt seal adhesive to retainer groove and install new felts. Apply support bearing lubricating oil to felt before assembly to axle. Ensure wheel hub is clean. Apply dust guard and ensure a good contact is made between the felt and the wheel hub.

Models D29, D31, D36

Current model motors are equipped with molded rubber dust guard and clamp. Check the molded rubber dust guard for signs of wear, cracks, or deterioration before assembly. Replace dust guard with a new dust guard if required.

Install the dust guard with the mounting lugs located in the support bearing flanges and the opening located toward the bottom of the traction motor (toward the rail).

AXLE SHIELD

The axle shield shown in Fig. 23 fits over the axle between the two support bearing caps and serves to prevent dirt from entering the bearing surfaces. It is installed prior to the installation of the bearing caps.

TRACTION MOTOR REMOVAL

REMOVAL OF WHEELS AND MOTOR ASSEMBLY FROM TRUCK WITH TRUCK UNDER LOCOMOTIVE

1. Remove cleats holding motor leads to underframe.

2. Loosen and slide traction motor connector covers along the motor leads.

3. Disconnect all of the motor lead connectors, taking care to see that all leads are plainly marked so there will be no difficulty in identifying them when they are reconnected.

4. Remove the flexible air duct on commutator end of motor.

5. Remove brake rigging from wheels to be dropped.

6. Block truck with jacks on both ends.

7. Remove the pedestal tie bar from both sides of truck on wheels to be removed.

8. Remove bottom pin keeper which holds motor nose in place on the nose suspension assembly as follows:

   a. Place a jack under motor frame and compress the motor suspension assembly.

   b. After compressing the suspension pack, place horseshoe shaped washers between the top spring holder and the heads of the spring holder bolts.

   c. Block under the traction motor before removing jack.

   d. Remove the bottom pin keeper which holds suspension assembly in place. Be sure to remove the pins which hold the spring holder and springs to truck frame.

   e. Remove the rubber suspension assembly by sliding it out from between motor and truck.

9. The motor and a pair of wheels are ready to be removed from the truck with a drop table.

REMOVAL OF TRACTION MOTOR FROM TRUCK WITH TRUCK REMOVED FROM LOCOMOTIVE

1. Remove cleats holding motor leads to underframe.

2. Slide the insulating tubes covering the connections along the motor leads.

3. Disconnect all of the motor lead connectors, taking care to see that all leads are plainly marked so there will be no difficulty in identifying them when they are reconnected.

4. Traction motor is now free and can be removed with truck.

5. Remove the dust guard on the commutator end.

6. Remove the bolts that secure the gear case.

7. Pull out gear case clips.

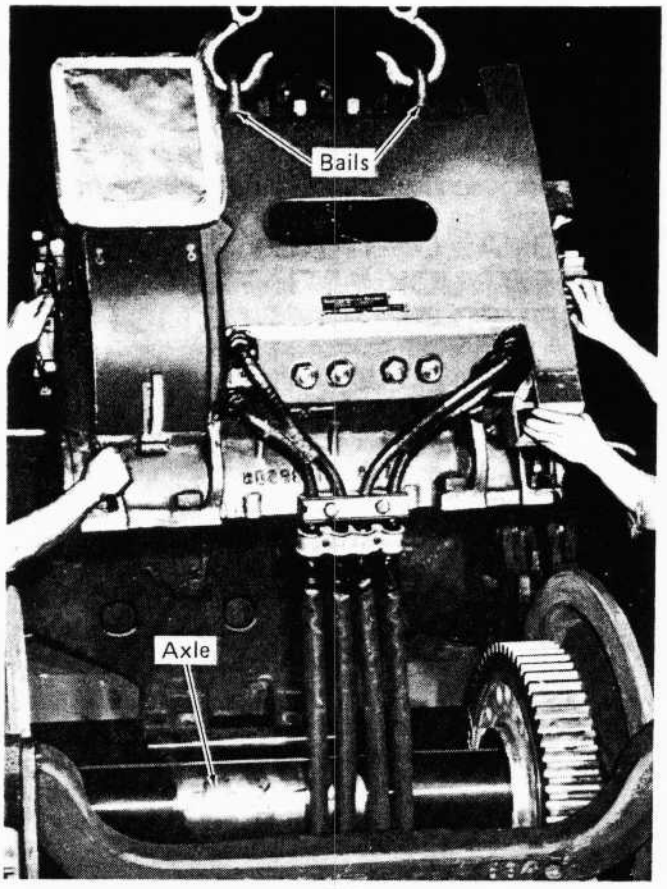
8. The lower half of the gear case will drop down and the upper half can be lifted off.

9. Remove the support bearing cap bolts, the caps, the axle shield and the outside bearing shell.

10. Remove the bolts on the motor side of the flexible air duct.

11. Remove bottom pin keeper which holds motor nose in place on the hose suspension assembly. Refer to Removal Of Wheels And Motor Assembly From Truck With Truck Under Locomotive procedure, Step 8.

12. Lift the motor out of the truck with a crane, hooking the lifting chains into the bails on the nose side of the motor frame, Fig. 24. Rotate the motor around the axle sufficiently so that the lower lip of the support bearing housing will clear the axle and lift vertically out of the truck. Do not allow the inside bearing shell to fall on the floor.



NOTE
Traction motor pictured is not correct model, but is used to show proper removal setup.

23329

Fig. 24 – Removing Traction Motor

NOTE

When mounting or removing a traction motor from a truck, or while handling in the shop, be sure that the pinion protector is applied. Care should always be taken to prevent the pinion from accidentally striking some object, since due to the weight of the motor it is possible to damage the pinion as well as the commutator end bearing assembly on armature shaft.

TRACTION MOTOR NOSE SUSPENSION

Each time power is applied to the traction motors the torque reaction tends to rotate the motor on its bearings. This movement of the motor is arrested by heavy lugs on the motor frame coming in contact with the top and bottom of a nose suspension assembly that is fastened to the truck frame bolster.

Current model traction motors have an improved traction motor nose suspension assembly made of resilient rubber pads and steel plates, Fig. 25.

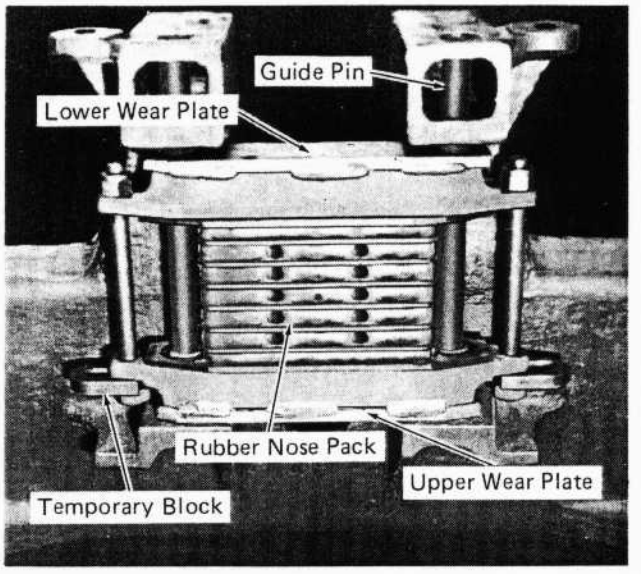


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Fig. 25 – Traction Motor Nose Suspension Assembly

This assembly is completely interchangeable with the previously used coil springs, and uses the same spring holders, wear plates, pins and bolts.

The wear plates on the suspension assembly are subjected to serve shocks and tremendous pressures, causing them to wear, resulting in free movement between the traction motor frame and the suspension assembly. As this free movement increases, due to wear, the severity of the shocks increases, especially if the wheels slip or during rapid changes of torque, such as applying sand during a slip.

It is recommended that wear plates be periodically reconditioned to ensure not more than 6 mm (1/4") free movement in the traction motor nose suspension to obtain maximum cushioning effect.

Traction motor frame assemblies are equipped with manganese steel nose suspension wear plates, Fig. 26.

Refer to Section 3 of Maintenance Instruction M.I. 3952 for wear plate wear limits and replacement procedure.

PINIONS

The pinion mounted on the traction motor armature shaft is carburized, which provides an extremely hard outer surface yet retains a desired soft core. The number of teeth on the pinion and mating axle gear determine the locomotive gear ratio. Various gear ratios are available to suit specific locomotive service requirements. Pinions will vary from 14 teeth to 25 teeth depending upon installation.

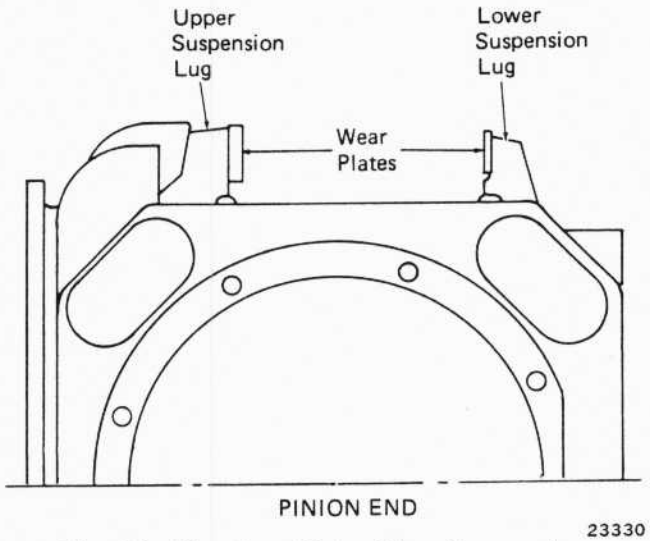

Fig. 26 – Traction Motor Nose Suspension Wear Plates

PINION REMOVAL

Pinions are heated and shrunk onto the shaft to provide the fit necessary to withstand the strain imposed in operation. The pinion is either removed by pulling off with a hydraulic puller or by "floating-off" by means of hydraulic pressure.

Refer to Service Data for special equipment required for pinion removal. The pinion is removed as follows:

PINION REMOVAL WITH HYDRAULIC PULLER

1. Remove the nut from end of armature shaft with a retaining nut wrench and handle, Fig. 27, or with an air impact wrench.

2. Clean threads in pinion and in pulling pilot.

3. Apply spacer between the end of the armature shaft and the ram of the puller to protect the shaft from possible damage.

4. Install threaded pilot and hydraulic puller assembly, Fig. 28, using a suitable hoist. The threaded pilot should enter the threaded portion of the pinion to its complete depth so threads will not strip.

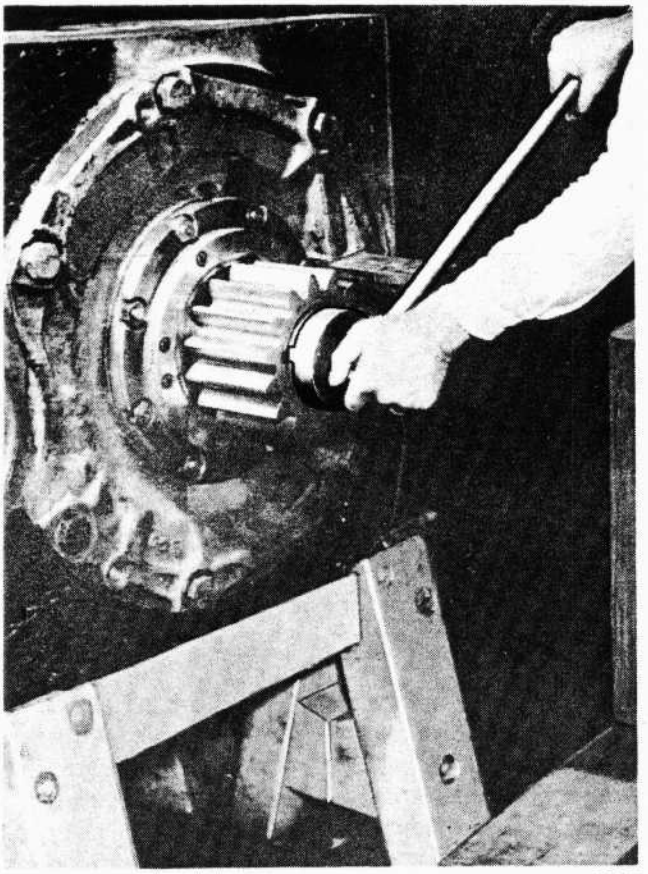

Fig. 27 – Removing Pinion Retaining Nut

WARNING

Remove hoist before attempting to pull pinion. Pinion releases suddenly and if left suspended on hoist, can swing violently.

Clear area in line with pinion to avoid damage to equipment or injury to personnel when drive pinion releases.

5. Pump hydraulic puller to build up pressure and remove pinion from shaft.

PINION REMOVAL BY FLOAT-OFF METHOD

The float-off method of pinion removal can be used on armature shafts which are manufactured with a groove around the shaft taper which is connected by drilled passages to a 1/2"-20 tapped hole in the center of the shaft, as shown in Fig. 29. The pinion is removed by applying high pressure oil through the drilled passages to the inside of the pinion bore, which results in the pinion being released from the shaft.

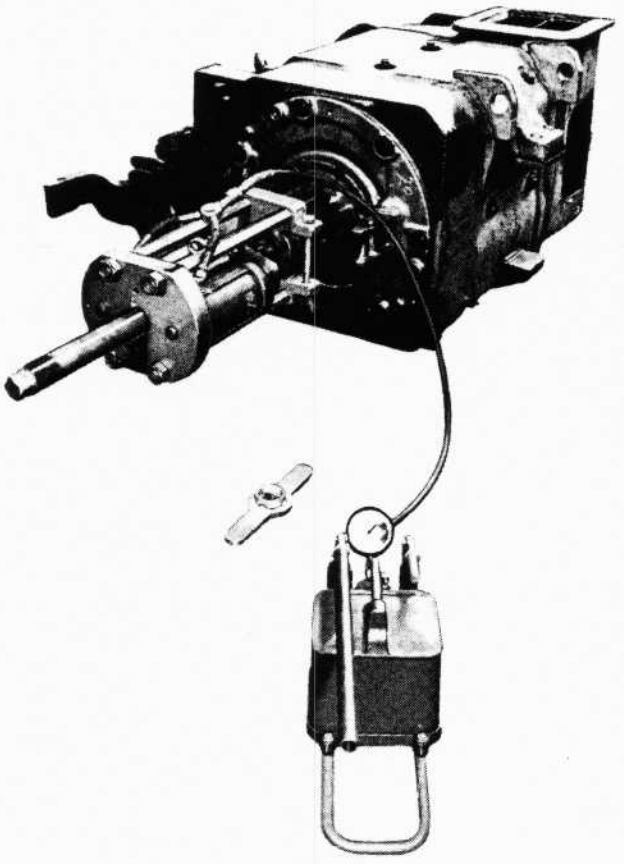

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Fig. 28 - Hydraulic Pinion Puller

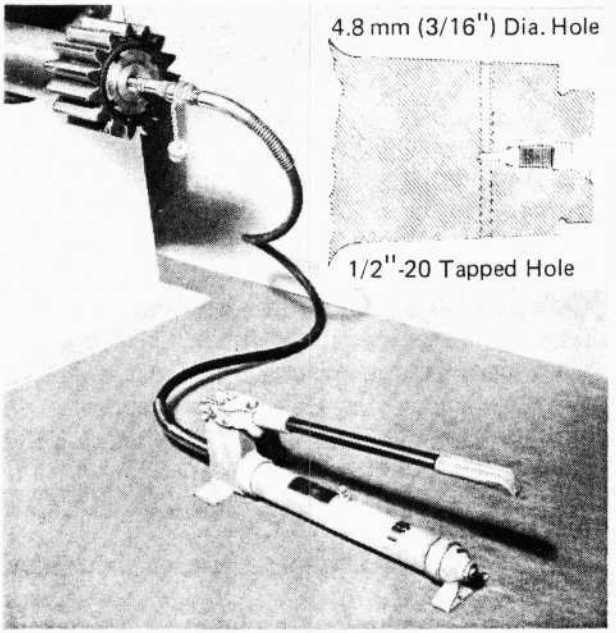

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Fig. 29 - Float-Off Pinion Removal

1. Loosen the nut on the end of the armature shaft with a retaining nut wrench and handle, Fig. 27, or with an air impact wrench approximately one turn, but do not remove.
2. Clean the center of the armature shaft and remove 1/2"-20 socket head setscrew. Ensure the threads and pressure fitting seat are clean.
3. Screw adapter nipple into shaft and tighten to 35-40 N·m (25-30 ft-lbs). Do not overtighten as this will damage the shaft seat.
4. Connect adapter nipple to the hydraulic pump with high pressure hose assembly. Close screw on pump and operate lever to build up pressure. When pressure becomes great enough, pinion will be released from armature shaft and will move off against the retaining nut.
5. Remove equipment and replace setscrew in end of 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 (non-drying) 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-eight 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 13 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. 30.

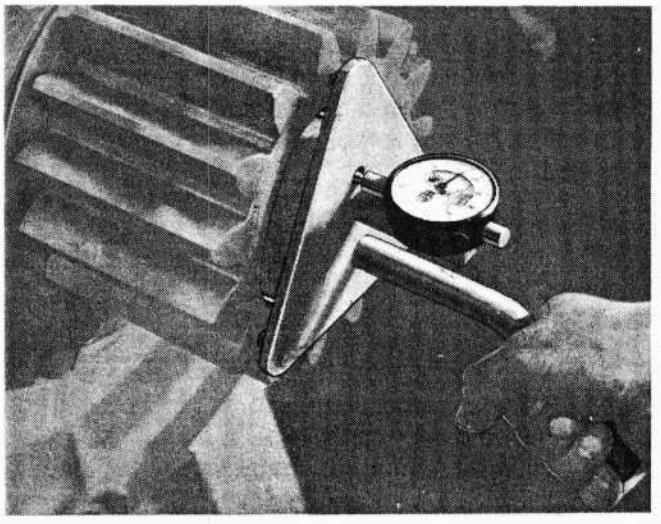

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Fig. 30 – Measuring Pinion Advance

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 5, 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 6. 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. 31, 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 slippage. The liquid cleaner should not be used on larger pinions as it will make pinions extremely difficult to remove.

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.

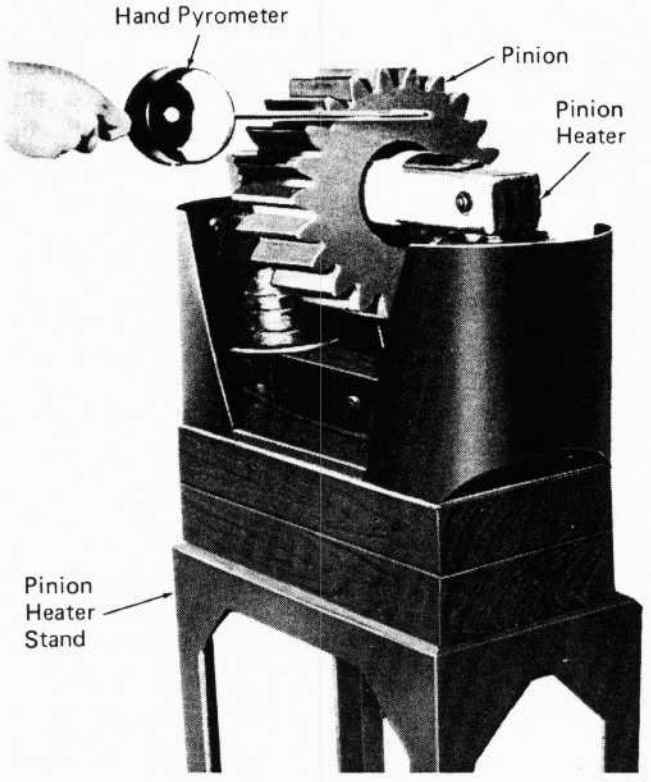

Fig. 31 - Induction Heater

a. When applying 14 and 15-tooth 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 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 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.

b. Heat pinion to the temperature specified in 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.

EXTERNAL LEAD AND CONNECTOR INSPECTION

1. Cable insulation should not be damaged, frayed, or worn. Carefully check areas where cables are clamped or subjected to abrasion.

2. Contact area of connectors should be free of protruding nicks and burrs. The connectors should have a smooth, flat surface.

3. There should be no broken strands of cable at point of entry into connector. Inspect solder at the top of the connector for cracks. The gap between the insulation and the connector should not be greater than 16 mm (5/8").

4. Check grommets for deterioration, cracks, wear, and looseness to the frame.

5. The condemning limit of the external cable length without lugs is 1 168 mm (46") minimum. The condemning length of the external cable length with lug is 1 253 mm (49-5/16") minimum, measured from the outside edge of the cable clamp to the tip of the connector. Lead lengths are not to vary more than 38 mm (1-1/2") between the longest lead and the shortest lead, but never shorter than the condemning limit.

EXTERNAL LEAD AND CONNECTOR REPAIR

1. If the motor does not have a grounding cable, Fig. 1, install grounding cable as follows. Refer to Service Data for grounding cable and heat shrinkable tubing part numbers.

   a. Attach grounding cable as shown in Fig. 32.

   b. Ensure external lead cable is dry and free of oil, grease, foreign matter, and sharp edges.

   c. Position three sections of heat shrinkable tubing as shown in Fig. 32.

   d. Apply heat to heat shrinkable tubing using a heat gun. Apply heat to the center of the tubing and work toward one end.

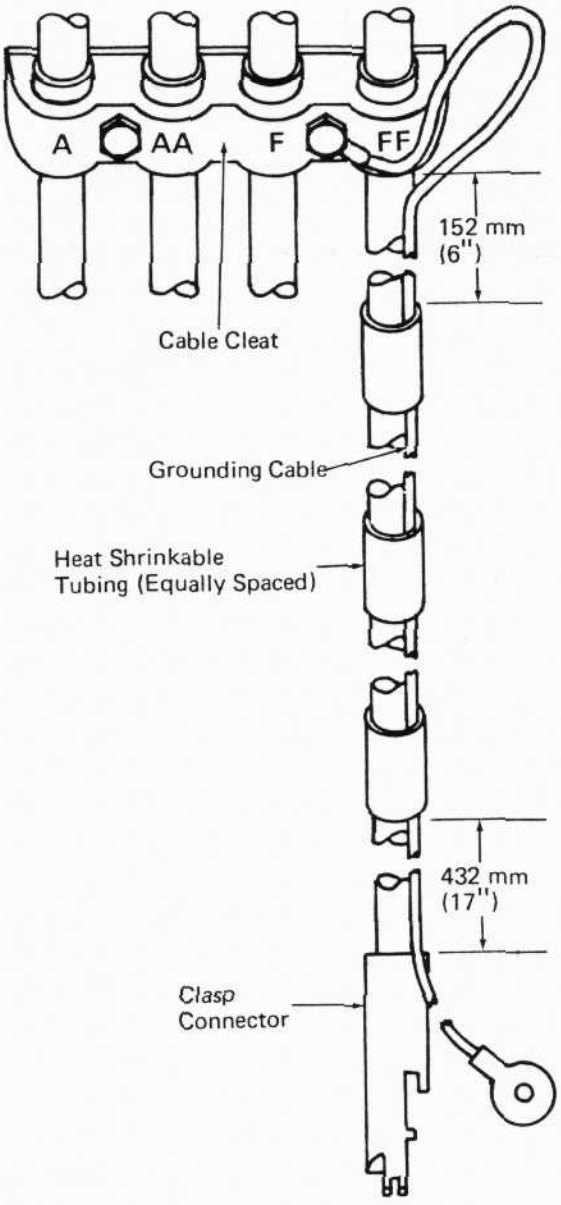

Fig. 32 - External Lead Grounding Cable Application

Apply heat again to the center of the tubing and work toward the opposite end. This procedure will assure an equal distribution of the longitudinal shrinkage. Apply heat only long enough to allow tubing to assume contour of the cable. Application of additional heat will serve no useful purpose.

2. Nicked or damaged insulation may be repaired with heat shrinkable tubing. A deep nick in the insulation can be cleaned with alcohol and filled with RTV compound prior to applying the heat shrinkable tubing. Refer to previous Step 1d for heat shrinkable tubing application procedure. Refer to Service Data for RTV compound part number.

3. If cable grommets are deteriorated, cracked, worn, or loose in the stator frame, replace with new grommets and seal with caulking compound. Refer to Service Data for caulking compound part number.

SOLDERING CONNECTORS TO CABLE LEADS

NOTE

Refer to Service Data for material part numbers.

Connector halves are secured to cable leads by a soldered joint. Joint should be soldered with a pure tin or tin base solder. Replace a connector as follows:

1. Heat the connector with a 2500 watt capacity thermo-grip pliers to the point where the solder melts to free the connector. Remove the connector. Refer to Service Data for thermo-grip pliers part number.

2. Heat the new connector with the thermo-grip pliers to the point where solder melts. Flux and tin the inside of the connector.

NOTE

If a solder pot is available, tin and heat inside of connector by slowly pouring hot solder back and forth between the ladle and the connector. Solder the connector by placing connector into a holding fixture, apply heat with the thermo-grip pliers, and pour solder from ladle into the connector.

3. Heat the cable end with the thermo-grip pliers. Flux and tin cable end.

4. Insert connector into a holding fixture and apply heat with thermo-grip pliers. Fill the connector barrel 1/2 to 3/4 full of solder.

5. Insert tinned cable end slowly into barrel of connector. Fill connector to the top edge. Maintain an even temperature and compensate for shrinkage as the solder cools. Remove thermo-grip pliers. Allow cable and connector to air cool. DO NOT QUENCH.

SUPPORT BEARING MOISTURE SEAL

Railroads experiencing accumulation of moisture in support bearing oil reservoirs can relieve the condition by applying a bead of RTV silicone compound at the traction motor axle cap split line and at the edges of the axle shield as indicated in Fig. 33.

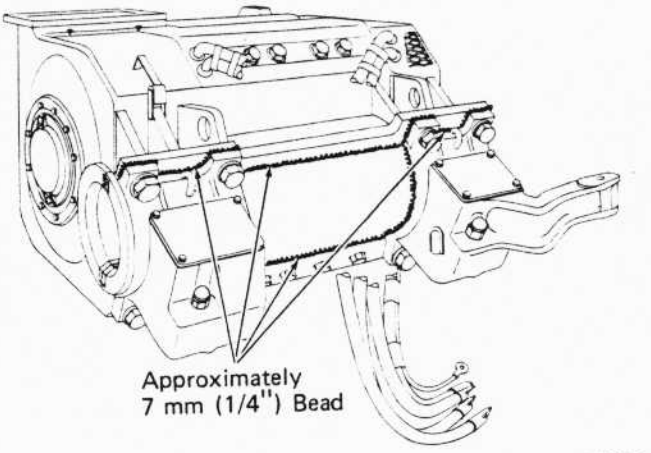

Fig. 33 – Support Bearing Moisture Seal

RTV silicone compound has excellent resistance to deterioration from exposure to weather, and can be peeled away readily when traction motor maintenance is required. Sealing is normally performed at traction motor changeout, but no disassembly or loosening of axle cap bolts is required. It is merely necessary to thoroughly clean all areas to which the sealer will be applied, then wipe the area with a solvent which will leave no oil residue. Sealing can best be done using 12 oz. cartridge and a standard caulking gun.

The bead of sealant must cover both metal surfaces and completely cover the parting lines of the axle shield. Particular attention must be given to the parting line above the top axle cap bolts where water is most likely to enter. If necessary, a pointed tool can be used to press sealant into the parting line area.

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. 34, 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.

22785

Fig. 34 – Support Bearing Oil Filler Cap

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

CHECKING TRACTION MOTOR ROTATION

When installing traction motor, it is important to verify that cable connections have been properly made by checking motor rotation. Failure to do so could result in serious damage to the motors and the generator. Refer to Fig. 35 to check cable connections.

The direction of motor rotation can be readily determined by observing the nose suspension when power is applied. The motor frame is restrained at this point by the nose suspension assembly, yet upward or downward movement, depending upon motor rotation may be observed.

When rotation of all motors has been determined to be correct, the locomotive may be returned to service.

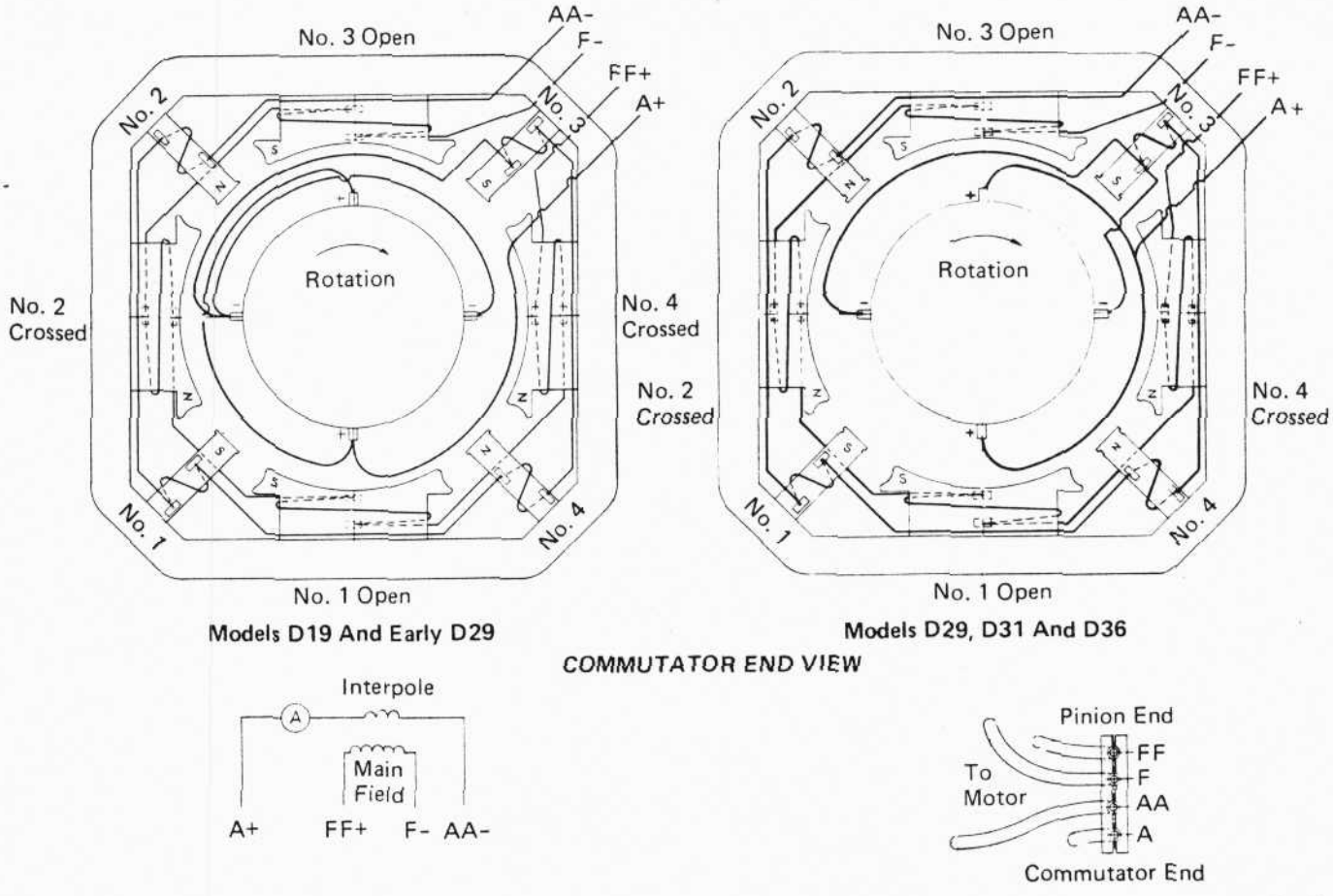

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Fig. 35 – Wiring Diagram

SERVICE DATA

SPECIFICATIONS

WEIGHTS (Approximate)

	D19, D29, D29CC	D31	D36
Complete Motor	2087 kg (4600 lbs)	2087 kg (4600 lbs)	1814 kg (4000 lbs)
Armature	549 kg (1210 lbs)	549 kg (1210 lbs)	454 kg (1000 lbs)
Gear Case	65 kg (144 lbs)	65 kg (144 lbs)	65 kg (144 lbs)

RESISTANCE AT 75° C

	Ohms ± 2%		
Armature	0.0476	0.04096	0.0434
Series Field	0.0272	0.0260	0.0239
Interpole Field	0.0174	0.01713	0.0155

BRUSH HOLDERS

Number Of Brush Holders 4
Clearance To Commutator . . . . . 3 - 5 mm (1/8" - 3/16")
Spring Pressure
- Coil Spring Type (at each finger) . . . . . 4 - 5 kg (9 - 11 lbs)
  - Minimum Completely Worn Brush . . . . . 3 kg (7 lbs)
- Constant Pressure Type
  - New Spring (at each finger) . . . . . 1.8 - 2.3 kg (4 - 5 lbs)
  - Used Spring (at each finger) Min. . . . . 1.6 kg (3.5 lbs)

BRUSHES

Coil Spring Type Holder
- Two wafer, flat top
- 54 mm x 44 mm x 16 mm
- (2-1/8" x 1-3/4" x 5/8")
  - Grade DE-5 8203773

Constant Pressure Type Holder
- Three wafer, notched top
- 57 mm x 44 mm x 16 mm
- (2-1/4" x 1-3/4" x 5/8")
  - Grade AC-35 8367716
- Three wafer, common rubber top
- 57 mm x 44 mm x 16 mm
- (2-1/4" x 1-3/4" x 5/8")
  - Grade DE-5 8430993
- Two wafer, notched top
- 57 mm x 44 mm x 16 mm
- (2-1/4" x 1-3/4" x 5/8")
  - Grade DE-5 8290119

PINION APPLICATION

	Pinion Advance	Approximate Temperature Rise Above Shaft Temperature
14 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)

COMMUTATOR

Mica Groove Width . . . . . 1.27 mm (.050")
Mica Groove Depth
- Minimum . . . . . 1.2 mm (3/64")
- Maximum . . . . . 2 mm (5/64")

GEAR CASE

Lubricant . . . . . as specified in M.I. 1756
Initial charge of lubricant . . . . . 3.6 kg (8 lbs)

SUPPORT BEARINGS

Lubricant . . . . . as specified in M.I. 1756
Lubricant Level
- Minimum . . . . . 90 mm (3-1/2")
- Maximum - Narrow window axle cap . . . . . Overflow
- Wide window axle cap . . . . . 152 mm (6")

BEARING LUBRICANT QUANTITY ± 7 g (1/4 oz.)

	PINION END		COMMUTATOR END	
	Kilograms	Ounces	Kilograms	Ounces
Cover	.198	7	.099	3-1/2
Inner Cap	.142	5		
Housing			.071	2-1/2
Roller Cage O.D.	.0355	1-1/4	.014	1/2
Roller Cage I.D.	.0355	1-1/4	.014	1/2
	.4110	14-1/2	.198	7

MATERIAL LIST

Armature Bearing Lubricant
- Sealed Grease Application
  - Shell Cyprina RA Grade 3
    - 16 kg (35 lb) Pail 8449819
    - 54 kg (120 lb) Drum 8249820
- Nonsealed Grease Application
  - Lubrico M6
    - 4 kg (10 lb) Pail 8102584
    - 11 kg (25 lb) Pail 8068104
    - 54 kg (120 lb) Drum 8102808
  - Regal Starfax No. 2
    - 16 kg (35 lb) Pail 8079816
    - 4 kg (10 lb) Pail 8085146

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.

Grounding Cable	8351902
Caulking Compound, 0.7 kg (1-1/2 lb) Can	8198204
Enamel, Red Air Drying	
1 litre (1 qt)	8061130
19 litre (5 gal)	8048876
Mineral Sprits	8492097
RTV, Silicone Compound 340 g (12 oz) Cartridge	8366747
Flux, Solder, 0.5 kg (1 lb)	8122570
Solder, Tin Base, No. 8 Wire, Approx. 23 kg (50 lb) Spool	8225761
Solder, Pure Tin, 7.3 kg (16 lbs)	8069984
Threadtex, Texaco, 19 litre (5 gal)	8307731
Tubing, Heat Shrinkable, 38 mm dia. x 76 mm lg (1-1/2" x 3")	8352037
Primer, Buff, 4 litre (1 gal)	8228726

SPECIAL TOOLS

Pyrometer, Hand type	8027937
Heater, Induction type pinion	8041446
Die, Armature Shaft rethreading	8050721
Die Holder	8050722
Protector, Pinion	8206970
Spacer	8116073
Handle, Sliding "T"	8127528
Wrench, Pinion Nut	8127529
Lifter, Brush springs	8140869
Depth Gauge, Pinion Advance	8160273
File, Commutator Slot	8238905
Thermo-Grip Pliers	8064918
Remover-Installer, Gear Case Filler Cap	8250241
Aligning Tool, Brush Holder Spring Cell	8305181
Adapter, Commutator Grinder	8204168
Commutator Grinder	8204166
Grinder Alignment Bar	8211051
Vacuum Cleaner Blower	8210140
Dust Collector	8210142
Grinding Stones, Finish Grade - 2 reqd.	8204167
Brush Seating Stone (Chalk Stone)	1A73686
Sandpaper, 220 Grit - 216 mm x 46 m (4-1/4" x 50 yd.) roll, 3 m (10 ft) per generator	19AB11
Hydraulic Pinion Puller Kit	8309742
Hydraulic Pump	8302969
Hydraulic Oil, 3.8 litres (1 gal)	8246430
Hose Assembly	8309741
Nipple, 1/2"-20	8309741
D29CC, D29CC-7, D29CCBT Axle Alignment Mandrel With Lifting Fixture	*File No. 904
D19, D29, D31, D36 Axle Alingment Mandrel With Lifting Fixture	*File No. 905

*File number represents facility drawing that the available (at no charge) from EMD Service Publication Department. These drawings include construction details of tooling that can be manufactured by the customer.

• • • • **A Service Department Publication** • • • •

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

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