ELECTRO-MOTIVE

M.I. 3900
*Rev. G

MAINTENANCE INSTRUCTION

GENERAL MAINTENANCE—MODEL D37, D47, D57, D67, D75, D77, AND D87 TRACTION MOTORS

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 recommended maintenance intervals specified in the applicable Scheduled Maintenance Program.

DESCRIPTION

All of the models are similar in appearance and are the same general size, Fig. 1. The differences are internal improvements to later models which have progressed from the original Model D37 to improve service life and to increase motor output.

The later model motors are similar to the Model D37 with the following differences:

A new axle cap oil overflow arrangement to prevent overfilling.

A manganese-steel wear plate to the motor nose support to obtain longer wear plate service life.

A new high temperature varnish.

Commutator end recabling to reduce temperature of commutator end bearing under high speed, high current, dynamic braking.

D47 Increased copper size in stator field.

D57 Application of a modified silicone varnish to armature coils to improve heat resistance, improved commutator seasoning, and the use of constant pressure brush holders.

D67 New armature coil construction to reduce temperature and moisture.

New type brush holders with longer brushes for extended brush life.

NOTE

The longer brushes cannot be used on Models D37, D47, or D57 unless brush holders are changed or modified.

Nylon grease retaining insert in pinion end bearing cover to prevent grease purging.

D77 A thinner armature insulation (polyimide film) which allows an approximate 20% increase in armature coil copper.

TIG (tungsten inert gas) welded joint between armature coil and commutator to ensure a more positive electrical connection.

Three-wafer resilient pad brushes to provide improved commutation and increase brush life.

Nomex V-rings in the commutator to improve commutator stability and performance.

*This bulletin is revised and supersedes previous issues of this number.
Areas of change are indicated by vertical bars.

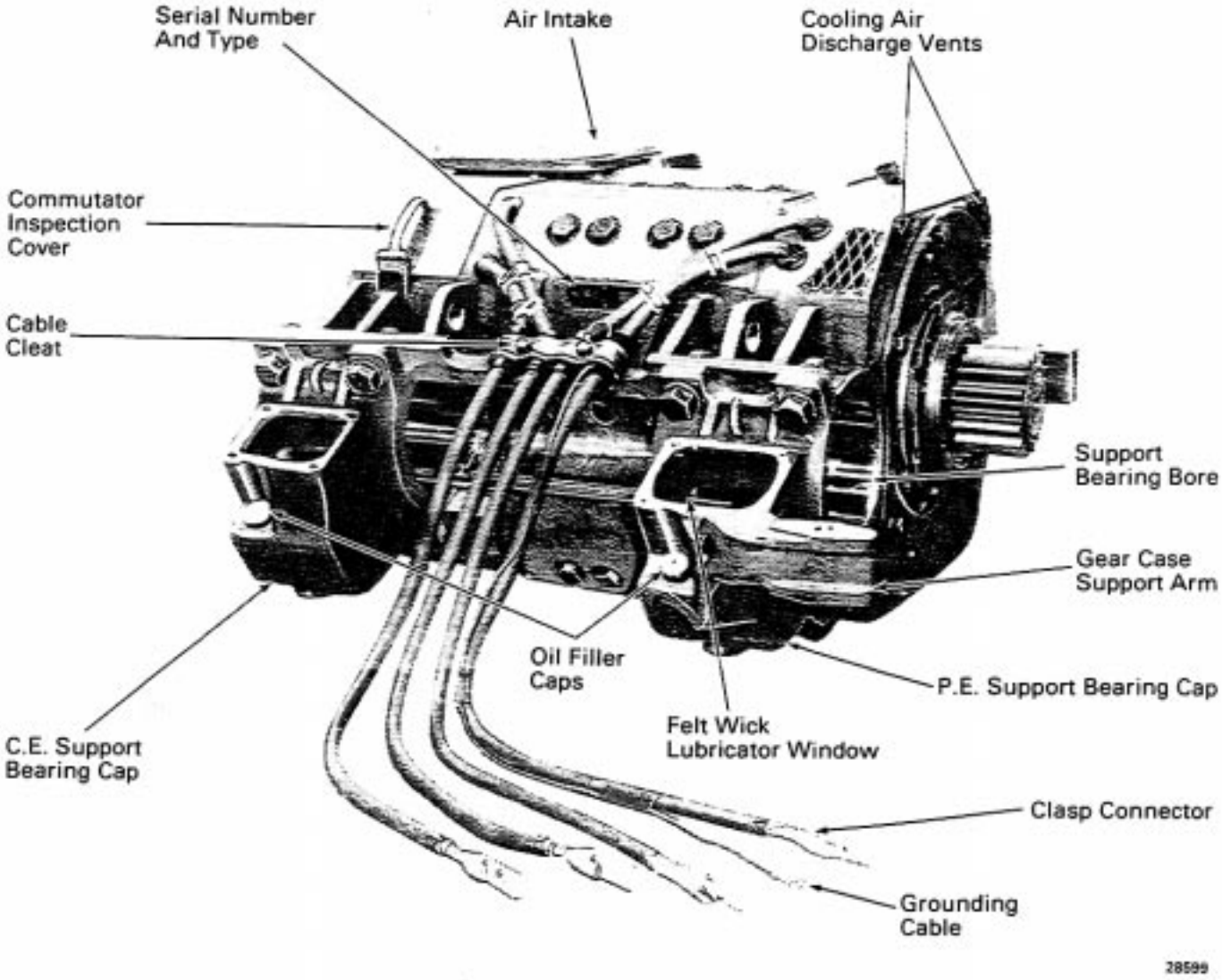

Fig.1 – Traction Motor

D87 Developed to support higher horsepower locomotives utilizing a new controlled wheel creep system.

Increased copper size in stator main field and interpole coils.

Increased copper size and transposed conductors (at center of armature core) in the armature coils.

Change in stator coil air baffles because of increase in the main field and interpole coil sizes.

Larger size pinion end bearing for additional load capability and a longer service life.

Redesigned bearing associated parts to accommodate larger pinion end bearing.

D87A New axle caps with increased oil capacity to further extend lubrication periods for reduced maintenance costs.

Increased thickness of lower mounting flanges on axle caps to allow use of 152 mm (6") long bolts (without spacers) and hardened flat washers for improved torque retention.

New twin seal axle support bearings with flange wicks positioned in from bearing split lines. New flange wicks have longer main body extending out to bearing flange O.D.

for improved lubrication – with ends sealed to prevent absorbtion of water or entry of dirt. Wicks compress into grooves for retention without adhesive to simplify application.

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 as well as insulated coils and windings.

CAUTION

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

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

All motors since the D57 have been equipped with constant pressure spring type brush holders. The D67, D77, and D87 motors use a brush holder which will accept a longer brush. This longer brush reduces maintenance by extending the period between brush changeouts. The D37 and D47 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. All early model traction motors rebuilt at the factory are equipped with the latest model brush holder.

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 possible loss of spring pressure such as the possibility that heat caused by a commutator flashover, caused spring pressure loss, the 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 brush holder and check as shown in Fig. 3. If the spring pressure is not within tolerance, replace the spring cell with a new spring cell.

COIL SPRING (ADJUSTABLE) TYPE BRUSH HOLDER

New or replacement brush holder springs for coil spring (adjustable) type brush holders should be set for an initial pressure of 4 to 5 kg (9 to 11 lbs) as

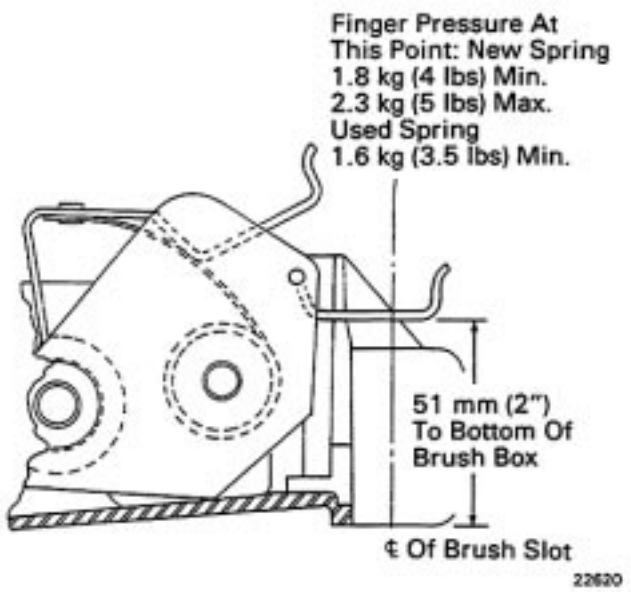

Fig.2 – Measuring Constant Pressure Brush Holder Finger Pressure (Spring Cell In Place)

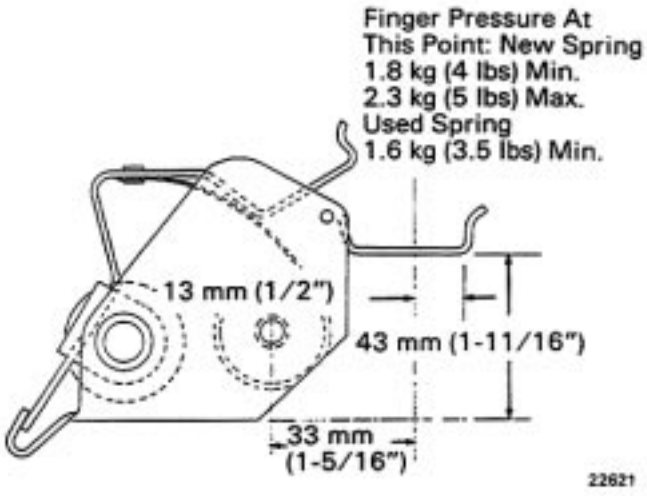

Fig.3 – Measuring Constant Pressure Brush Holder Finger Pressure (Spring Cell Removed)

measured with a spring tension scale with pressure spring lifted 3 mm (1/8") above the top inside 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 their 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.

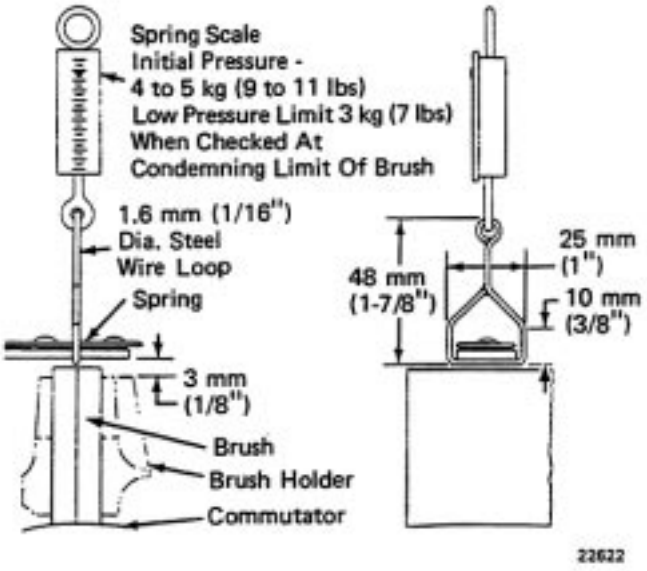

Fig.4 – Measuring Coil Spring Brush Holder Finger Pressure

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 – 95 to 102 N·m (70 to 75 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 insulated type brush holder studs are unusually resistant to flashover damage. If flashover damage should occur, these insulator studs usually can be restored to satifactory condition by polishing them with fine

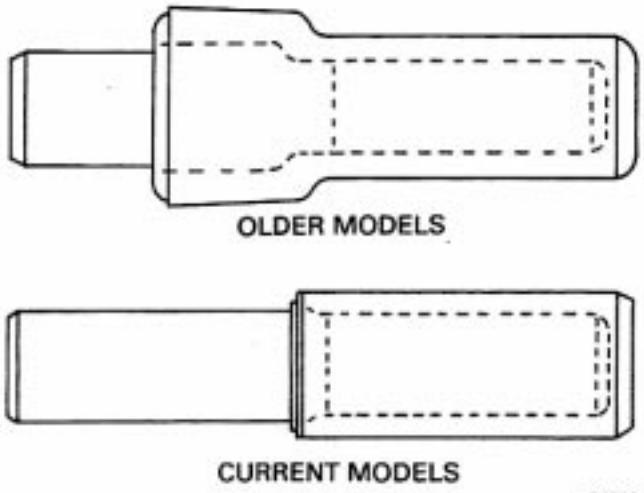

Fig.5 – Polyester Brush Holder Insulator Stud

sandpaper. Polyester glass material should never be subjected to alkaline cleaning solutions.

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.

Older model 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.

The current model brush holders have a silicone rubber boot which fits over the base of the stud and brush holder, Fig. 6.

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.

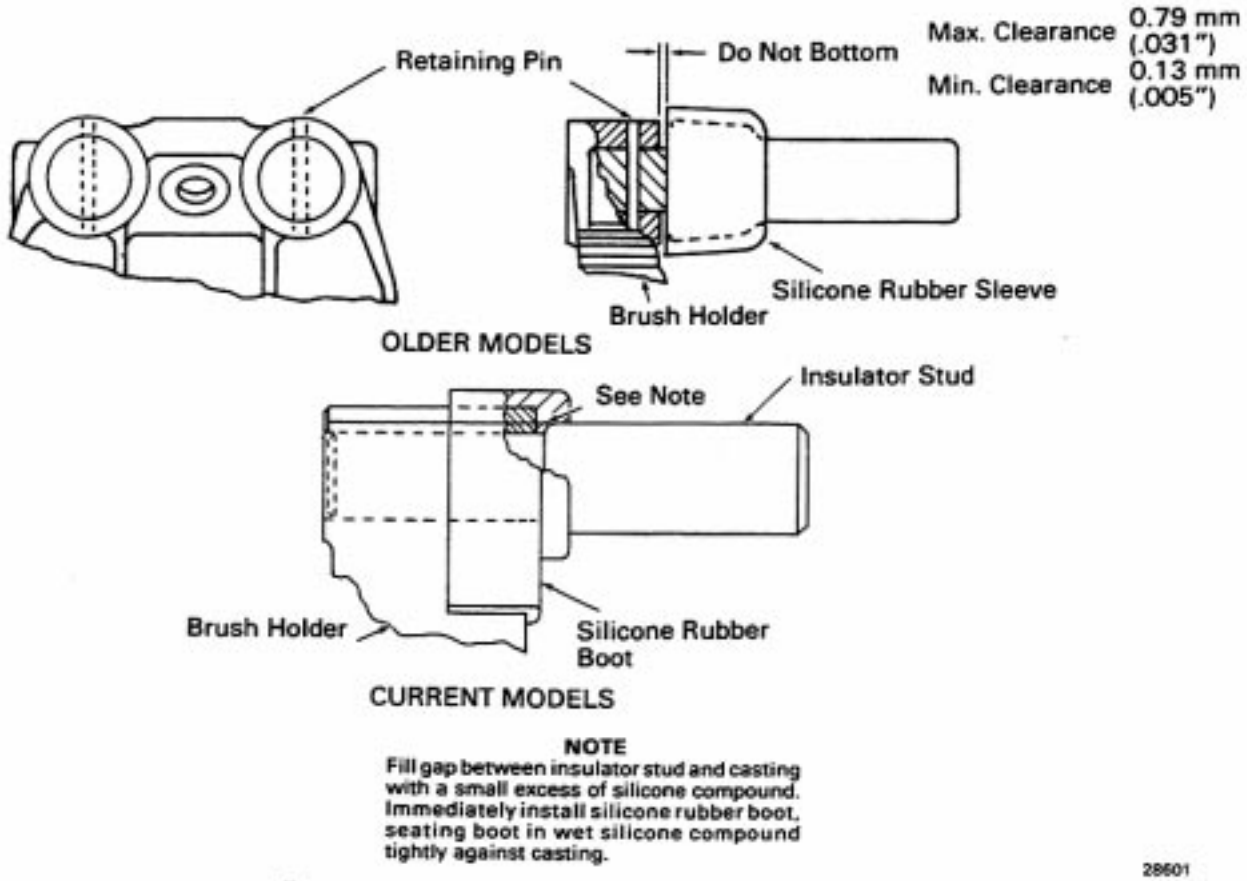

Fig.6 – Brush Holder Insulator Stud Installation

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.

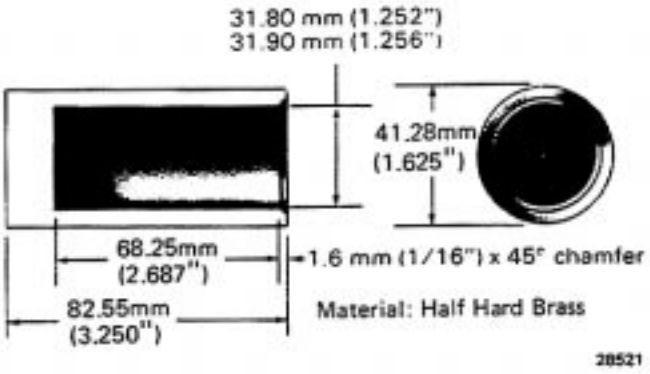

Fig.7 – Insulator Stud Installation Tool

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

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

2. Clean out 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, Fig. 7. Clearance between the stud shoulder and brush holder must be maintained to ensure the insulation does not get damaged against the brush holder.

4. On older model brush holders, 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.

   On current model brush holders, fill the gap between the insulator stud insulation and the casting with a small excess of silicone compound. Immediately install silicone rubber boot, seating boot in wet silicone compound tightly against the casting. Refer to Service Data for silicone compound part number.

CONSTANT PRESSURE BRUSH HOLDER MAINTENANCE

SPRING CELL REMOVAL

When inspection indicates it is necessary to remove the spring cell assemblies from a current model brush holder, Fig. 8, perform the following:

1. Place brush holder fingers in "cocked" position.

2. Pry lower end of each pin (visible in the holes directly below and at each end of the spindle) slightly upward until pin protrudes from the top of the holder. Pull pin out of hole.

3. Drive spindle out of brush holder to free spring cell assemblies.

BRUSH HOLDER CLEANING

HEAVY CLEANING

1. To remove heavy carbon deposits, oil, grease, and severe burn marks, place the brush holders in a tank charged with one part emulsion soak cleaner such as Clifco No. 1 BH or equivalent mixed with four parts of water. Soak the brush holders at room temperature without agitation for 3 to 5 hours depending upon the condition of the brush holders.

CAUTION

Observe safety precautions when handling emulsion soak cleaner and store in a safety-type container. Cleaner as received from supplier has a flash point of 38° C (100° F). Mixed with water, it has no flash point. Rubber gloves should be used when using cleaner to prevent drying out the skin or possible irritation. Keep cover on tank when not in use and while brush holders are soaking.

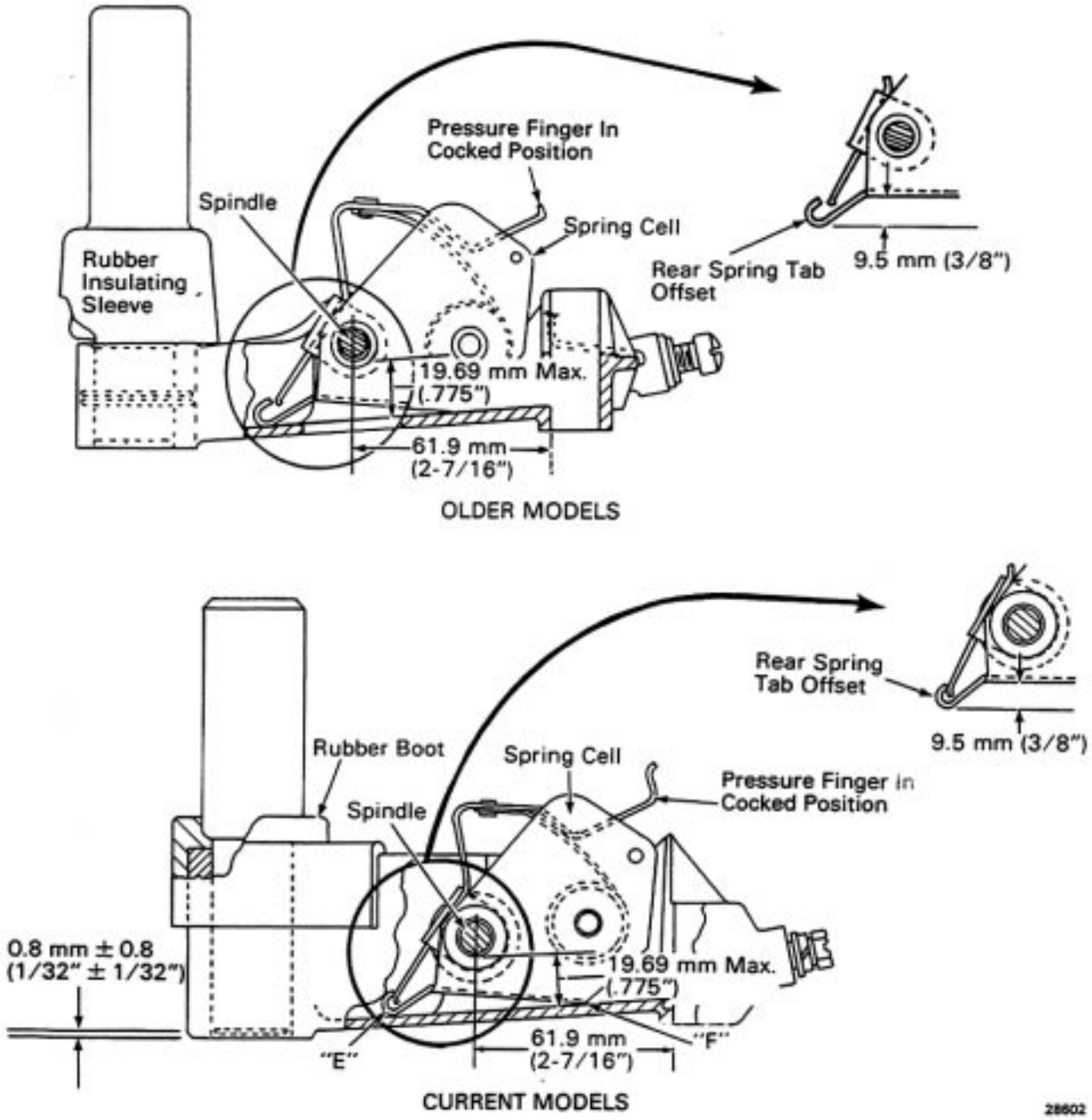

Fig.8 – Constant Pressure Brush Holder

2. Steam clean brush holders using a steam cleaner such as Dober Chemical Corporation Cleaner 6006 or Turco Chemical Company Steamfas. Operate steam cleaning gun nozzle from 25 mm to 150 mm (1" to 6") from surfaces being cleaned.

WARNING

Protect skin and clothing while steam cleaning. Operator should wear rubber apron, boots, gloves, and a plastic face shield.

3. Hose off brush holders with clear water.

LIGHT CLEANING

For light cleaning, brush holders should be cleaned by washing in a non-toxic solvent such as Stoddards Solvent. A solvent with a fast rate of evaporation is preferred.

WARNING

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

BRUSH HOLDER INSPECTION AND REPAIR

1. Inspect brush holder terminal lug seat for roughness and rework as required.

2. Check dowel securing the brush holder pins to ensure the casting is peened over at both ends.

3. Remove all arc burns and file off surfaces facing the commutator if metal buildup has occurred.

CARBONWAYS (BRUSH SLOTS)

Check carbonways for wear with gauge. Refer to Service Data for gauge part number. The carbonway should be between 15.90 mm (.626") and 16.13 mm (.635") in each brush slot. The short brush slot should be within 50.90 mm to 51.13 mm (2.004" to 2.013"). The long brush slot should be within 101.70 mm to 101.93 mm (4.004" to 4.013").

NOTE

Brush slots worn beyond acceptable limits cannot be repaired by peening and filing to gauge size. No protrusions are allowed in the brush slots. Some slight gouging in the top of the slot is permissible, providing it does not exceed 10 percent of the surface. Brush holders with excessively worn or damaged slots must be replaced.

SPRING CELL REPLACEMENT

Before replacing spring cell assemblies, inspect brush holder casting and insulator pins. Replace any defective parts with new parts. Repair all defects.

1. Insert the spindle in the spindle hole with the spindle pushed up against the top of the hole. Check the distance from the bottom of the spindle to the inside surface of the bottom web of the brush holder casting, as shown in Fig. 8. If this dimension is greater than 19.69 mm (.775") or if the hole is more than 51 mm (.020") oversize, the hole must be plugged and relocated.

2. Check rear spring tab to ensure that offset of tab is 9.5 mm (3/8"), Fig. 8. Bend rear spring tab as required. Place brush holder fingers in "cocked" position.

3. Place cell assembly in brush holder spring pocket with fingers centered within 0.8 mm (1/32") of slot "A", as shown in Fig. 9.

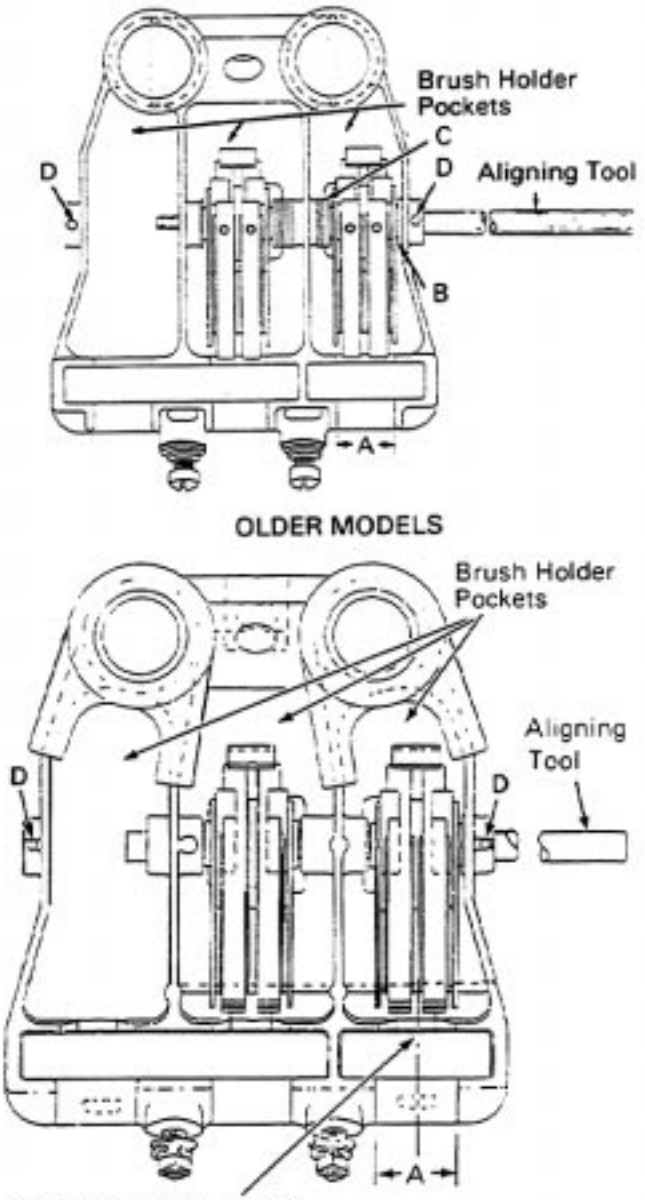

Fig.9 – Installing Spring Cell In Brush Holder

4. Insert aligning tool through spindle hole and spring cell, Fig. 9. Check alignment of spring cell with finger slot "A" and, if cell is out of line, remove aligning tool and reassemble.

5. Follow same procedure with center and left-hand cells. After each cell is assembled, recheck the alignment with finger slot "A".

6. When all cells have been installed, drive the aligning tool out of the assembly with the spindle. Continue to drive the spindle through until the spindle is centered in the brush holder.

7. Drill two 3.2 mm (1/8") diameter holes at area "D" of Fig. 9. Insert groove pins in each hole at area "D". Peen casting lightly into each hole to lock pins.

8. Ensure each spring cell is tight in the brush holder. If cells are properly installed, the cells will be held firmly at contact points "E" and "F" of Fig. 8. If required, adjust rear spring tab so that the cells are held firmly at points "E" and "F" when the spindle is driven in place. Points "E" and "F" must have definite contact with holder.

9. After assembly, release brush holder fingers from "cocked" position to prevent handling damage and to prepare assembly for installation.

CONVERTING COIL SPRING TYPE BRUSH HOLDER TO CONSTANT PRESSURE TYPE BRUSH HOLDER

The old style D37 and D47 coil spring type brush holders can be converted to a constant pressure type brush holder.

To prepare brush holder for conversion first dismantle it by removing the spindle, thimbles, and springs and thoroughly clean and inspect the brush holder casting and insulator studs. Any defects that are found should be repaired. The conversion procedure is as follows:

1. Remove all raised numbers, letters, trade marks or bosses from the spring cell pockets which will not allow the spring cell to seat firmly. Do not remove the oblong boss from the rear of the brush holder casting 8310010 but be sure this surface is reasonably parallel with the casting surface.

NOTE

Spindle 8081883 may be used if in good condition, but it is recommended that the new type spindle 8296216 is used.

2. Insert the spindle in the spindle hole and push spindle up against top of the hole. Check the distance from the bottom of the spindle to the inside surface of the bottom web of the brush holder casting, Fig. 8. If this dimension is greater than 19.69 mm (.775"), perform the following:

   a. Inspect spindle to spindle hole clearance. Maximum clearance of 0.51 mm (.020") is acceptable.

      If clearance is greater than 0.51 mm (.020"), inspect spindle. If spindle has cracks or has wear in excess of 0.25 mm (.010"), replace spindle with a new part. New spindle measures 9.462 mm – 9.525 mm (.3725" – .3750").

   b. If spindle is acceptable, repair spindle hole. Ream or drill worn spindle holes to 12.77 mm to 12.88 mm (.503" to .507") diameter.

      Clean and flux the drilled holes and plugs to be used. Use a low temp brazing flux for general use with silver brazing alloy such as Handyflux. Refer to Service Data for plug part number.

      Insert plug in drilled hole and silver braze in place. Use a low temp, general purpose, 50% silver, brazing alloy. Use care not to overheat and warp brush holder during brazing.

      Clean in hot water.

      Redrill holes to 9.35 mm (.365") maintaining the 61.9 (2-7/16") and 19.69 mm (.775") dimensions, as shown in Fig. 8.

      Ream the 9.35 mm (.368") drilled holes to 9.57 mm – 9.65 mm (.377" – .380").

3. The rear tab of each new spring cell which is furnished with the conversion kit, is correctly adjusted for a 9.5 mm + 0.8, -0 (3/8" + 1/32" -0) offset as shown in Fig. 8. If spring cell is being reapplied, make certain that this dimension is correct before applying the cell to the brush holder. If necessary, bend rear spring tab to correct dimension.

4. Place spring cell fingers in "cocked" position as shown in Fig. 8 when assembling cell to holder.

5. Center a spring cell assembly in right hand pocket and align with finger slot "A" as shown in Fig. 9.

6. Insert aligning tool through spindle hole and spring cell being sure to add necessary washers at areas "B" and "C" as shown in Fig. 9. Check alignment of spring cell with finger slot "A" and if cell is out of line, remove aligning tool and reassemble.

7. Use the same procedure with the center and left hand cells being sure to use as many washers in

the lineup as possible. After each cell is assembled re-check its alignment with finger slot "A".

8. When all cells have been installed, drive the aligning tool out of assembly with the spindle. Continue to drive the spindle through until it is centered in the brush holder.

9. Drill two 3 mm (1/8") diameter holes at "D" Fig. 9. Insert groove pins furnished with the conversion kit and peen holes to hold pins. Check to see that the spring cell is tight in the brush holder.

10. After assembly, release spring cell fingers from cocked position to prevent handling damage and to prepare assembly for installation into motor.

COMMUTATOR BRUSHES

Currently motors are equipped with a three-wafer resilient pad brush which, as stated previously, improves commutation and increases brush life.

Three split type brushes are used in each of the four brush holder assemblies. The 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 by hand. The new constant pressure brush holder springs must be raised by hand and placed in a "cocked" position, Fig. 8, but the older coil spring brusher holder springs may be lifted with the use of a lifter as shown in Fig. 10.

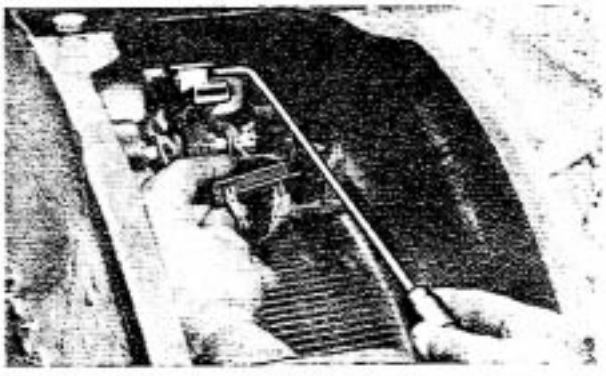

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Fig.10 – Brush Inspection

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.

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. 11, the brush should be replaced.

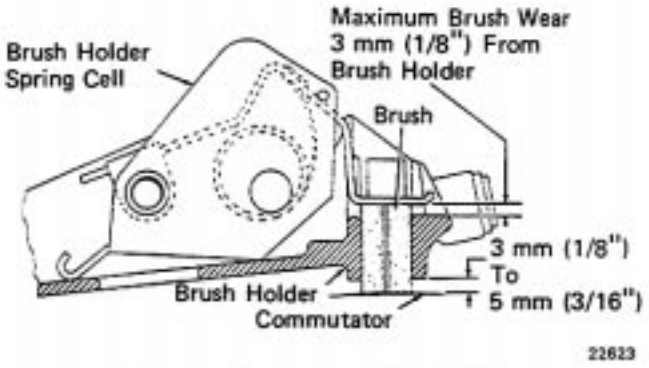


Fig.11 – Measuring Brush Wear

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.

NOTE

Currently 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 do not require sanding.

If old brushes are used, they should be installed in the same position in the brush holder from which they were removed. If brushes lacking the contour at the commutator end of the brush are to be 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. 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 equipped with a teflon sleeve over the string band and TIG welded commutator terminations, Fig. 12, 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 epoxy or red enamel and soldered commutator terminations, Fig. 12, should be cleaned and recoated with red air drying insulating enamel whenever necessary. The procedure for repainting this surface is as follows:

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.

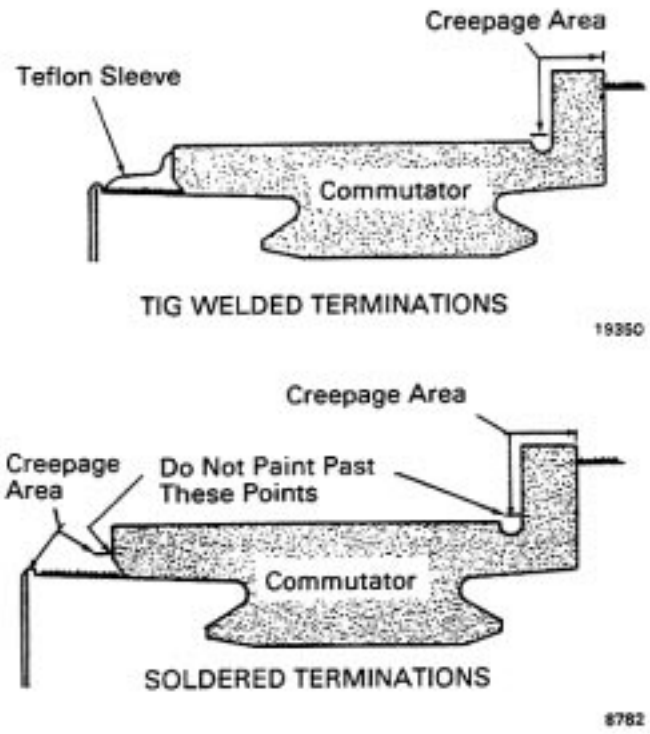


Fig.12 - Care Of Commutator Creepage Area

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") 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. 13 and check the grinder as follows:

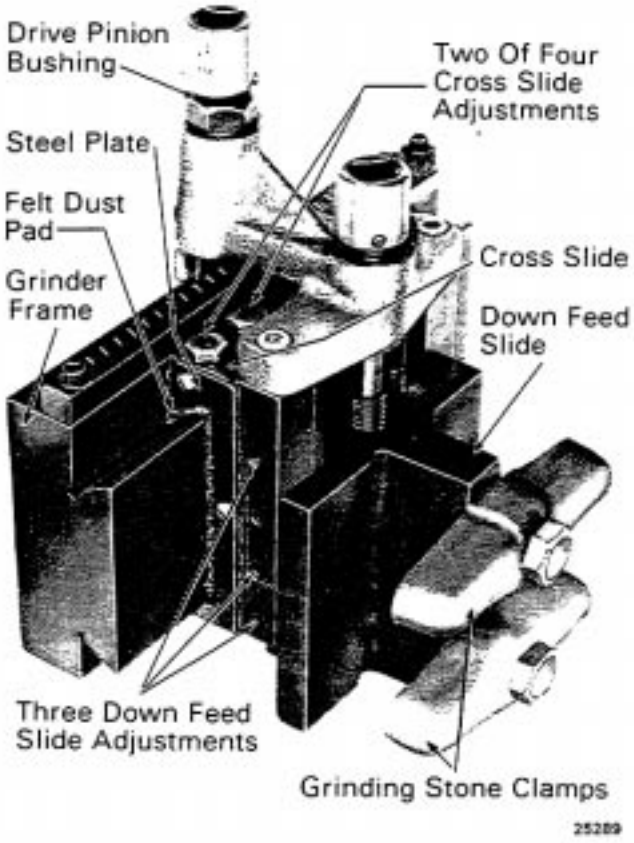


Fig.13 – Commutator Grinder Adjustments

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

There are two grinding adapters available for use, either of which will provide a satisfactory mounting for the grinder. Adapter 8354239, Fig. 14a, requires the removal of the top brush holder from the motor and the adapter installed in the brush holder mounting blocks. Adapter 8354226, Fig. 14b, is mounted on the motor frame over the large bottom inspection opening and does not require removal of the brush holder.

ADAPTER 8354239 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.

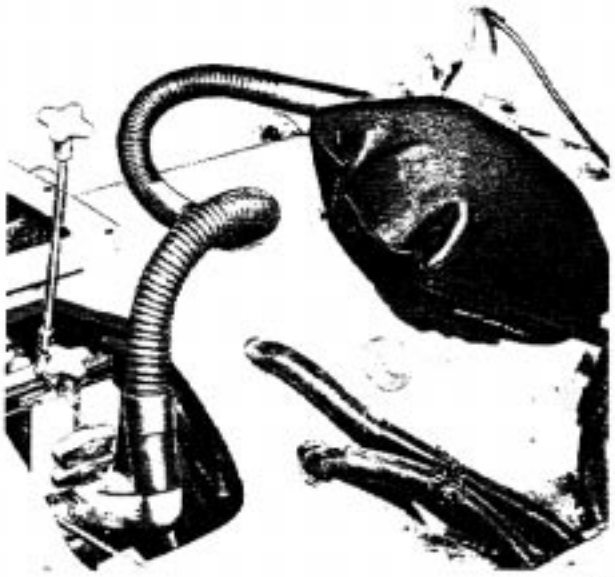
3. Install the adapter and secure it with the brush holder clamp and bolt.

ADAPTER 8354226 INSTALLATION

1. Place motor on a stand at least 75 cm (2-1/2 ft) above the floor level.

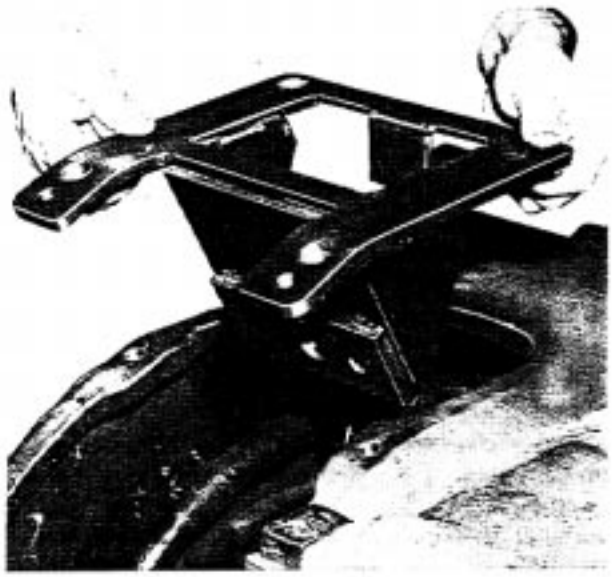
NOTE

The adapter has four bolt clearance holes (unthreaded holes) and two threaded 1/2"-13 holes. The two threaded holes should have a bolt installed that has at least 64 mm (2-1/2") of thread. The function of these two bolts is to provide a variable adjustment that will compensate for the different frame design (fabricated or cast) and also the frame contour irregularities. The adapter is mounted to the frame with two 1/2"-13 bolts at the bottom and two 1/2"-13 bolts located at the center of the inspection opening. The end of the adapter having one bolt clearance hole on each side should be towards the bottom of the motor frame.



8546

(a) Brush Holder Mounted



13654

(b) Frame Mounted

Fig.14 – Commutator Grinder Application

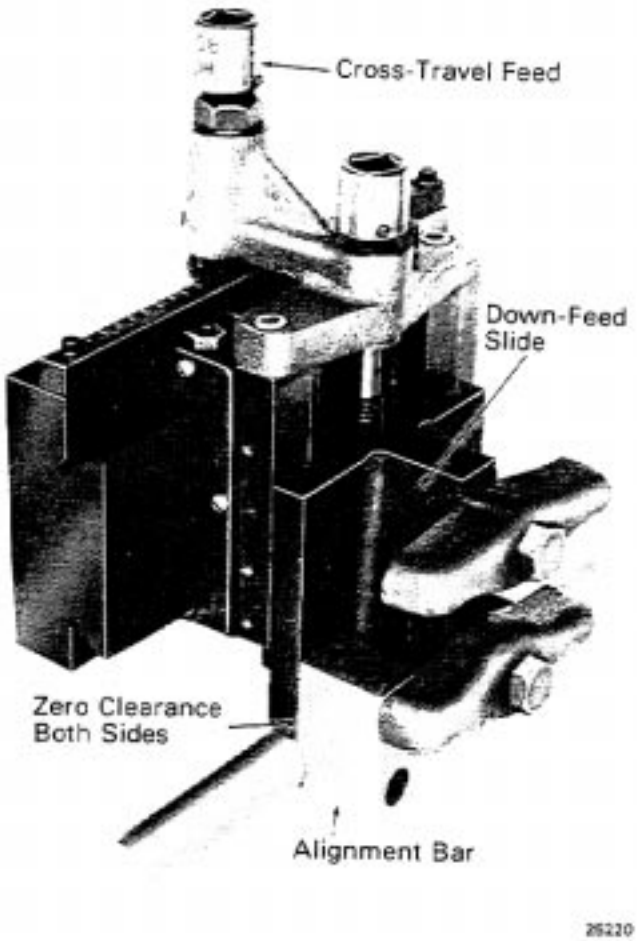
2. Mount the adapter on the motor frame with four 1/2"-13 bolts, but only tighten the two bottom bolts. Tighten the bolts in the threaded holes until the bolt ends contact the motor frame. Do not continue to tighten the bolts as this will tend to distort the adapter frame. When both bolt ends contact the frame, the two bolts through the clearance holes should be tightened to secure the adapter to the motor frame.

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. 15. Any clearance at either side of the alignment bar contact surface indicates the bar is not parallel to the grinder.

2. Install the grinder with the alignment bar on the adapter. When frame mounted adapter is used, the brush shunts in the bottom brush holder should be checked for maximum clearance to the grinder.

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.



26220

Fig.15 – Commutator Grinder Alignment Bar Installation

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

Commutators 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 deterioration 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 stone 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. 16, to undercut the mica to proper depth. Do not exceed the undercut maximum depth of 2 mm (5/64").

8530

Fig. 16 – 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. Effective with D67 traction motor, and available for older models, is a sectionalized nylon insert installed in the pinion end bearing cover to prevent an excessive amount of grease from being moved into the rollers by slumping action caused by vibration. This reduces "churning" of the grease which in time causes the grease fibers to become soft and susceptible to purging. These factors should permit the motor to be operated without further bearing attention to the motor overhaul period specified in the applicable Scheduled Maintenance Program. For information on repacking these bearings refer to Maintenance Instruction M.I. 6850.

GEAR CASE AND GEARS

The gear case houses the traction motor pinion and mating axle gear, protecting them from dirt or

damage and also carries the gear lubricant. The case is made of two close fitting halves with seals to provide complete contact and closure.

NOTE

Previous model gear cases were equipped with removable gutters over the upper cover axle bores to divert the flow of grease away from the seal surfaces.

The current gear case (manufactured after mid 1982) is equipped with plastic seals at the axle bore. These seals have integral 360° gutters and running clearance type labyrinth seals that fit around the axle on either side of the gear. Seals engage the gear case side sheets by means of a circumferential groove. Metal-backed felt seals are installed at the pinion bore and string covered cotton cording is used in the parting line channels of the upper gear case half.

The inspection opening and grease filler cap is located at the axle end of the upper and lower halves of the case. This makes it more convenient for inspecting gears, checking 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. 17.

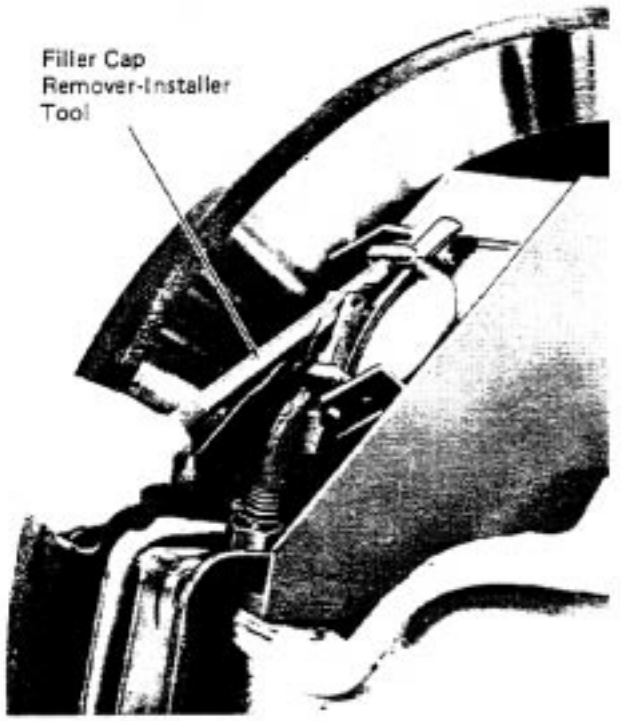


Fig.17 – Filler Cap Removal Tool

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.

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.

NOTE

The current plastic gear case seals at the axle bore reduce lubricant leakage, extend maintenance intervals, and substantially decrease the occurrence of dry gear cases. Electro-Motive recommends that a gear case designed for metal-backed felt seals at the axle bore be modified to receive the new plastic seals. Refer to Maintenance Instruction M.I. 9656, Gear Case Modification And Application Of Plastic Gear Case Seals.

This modification does not apply to gear cases 8301946 and 8302645 due to the small axle bore for use on 36" wheels with 12" hubs.

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. Two pounds of recommended lubricant should be added 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

When a gear case is removed from a traction motor/wheel axle assembly, the case should be cleaned and qualified prior to reassembly to assure

that only those gear cases which are capable of satisfactory performance will be reused. Refer to Maintenance Instruction M.I. 1520 for gear case inspection, repair, and seal application procedures.

GEAR CASE REASSEMBLY

1. Prior to reassembling the gear case, check the following:

   a. Ensure the drain slot between the 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.

NOTE

Current plastic seals are positioned with split line at the 6:00 o'clock position to align drain slot on inboard side of seal with drain duct on inboard side of lower gear case half. Locating keys are used at the 12:00 o'clock position on the upper gear case half to engage slots in seals to prevent outboard seal from rotating with wheel hub.

   b. Ensure lubricating oil has been generously applied to the pinion felt seals.

2. Assemble gear case to the traction motor/wheel axle assembly. Tighten the mounting bolts and torque to 1 220 N·m (900 ft-lbs). Apply lockwire. Failure to properly tighten the bolts can result in excess wear caused by vibration on the support bearing cap and pinion end bearing cover supporting arms.

3. Charge gear case with recommended lubricant as specified in Service Data. 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.

4. After an initial trip, check gear case condition and lubricant level. Check level through lower fill opening to ensure a full tooth dip into lubricant. Add lubricant as 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 of the current narrow window type 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.

A narrow window traction motor support bearing cap and support bearing arrangement has been in use since the late D47 traction motor. The narrow window provides increased oil capacity and larger bearing surface as well as an improved wick lubricator, Fig. 18. Proper oil level on motors with narrow window bearings is maintained by filling to the point of cap overflow.

Early D47 and previous model traction motors with wide window bearings should have the lubricating oil level maintained between the limits of 127 mm (5") maximum and 63.5 mm (2-1/2") minimum. This level can be measured using a clean steel rule or rod with increment markings inserted into the oil filler opening, parallel to the oil fill pipe as shown in 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. New and rebuilt D87 series traction motors should have an additive supplement with extreme pressure properties included in the initial charge of gear lubricant during the break-in period. Refer to Service Data for additive part number.

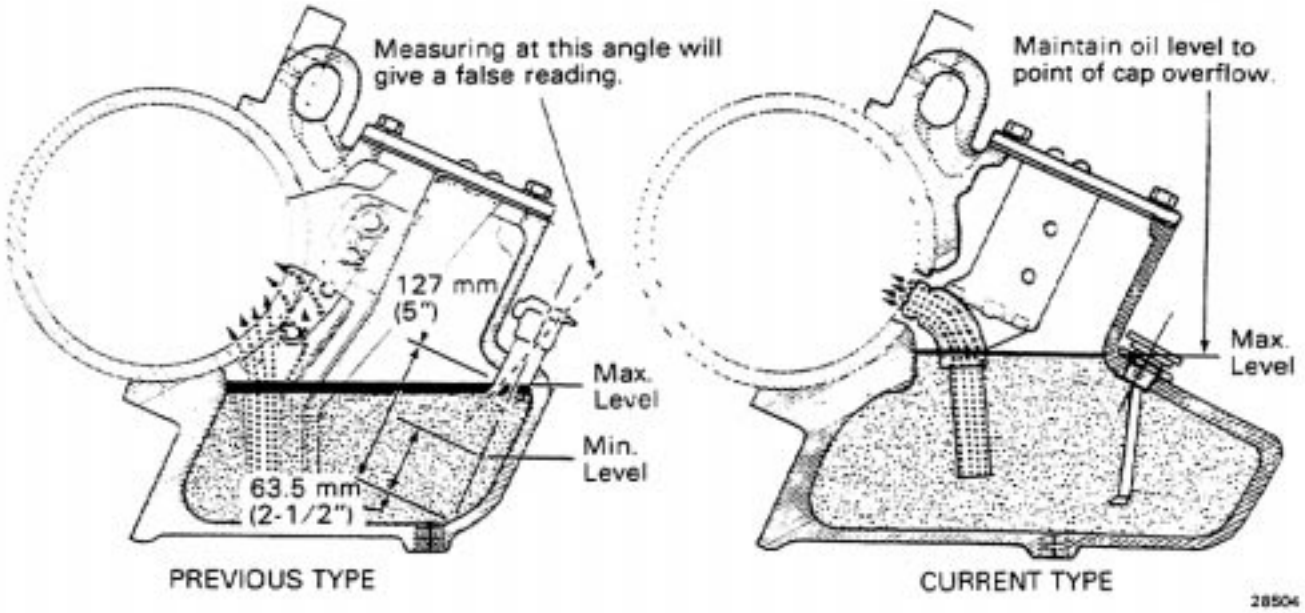


Fig.18 – Motor Support Bearing Oil Levels

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. Refer to Step 14 of Felt Wick Lubricators paragraphs. 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 a winter season.

1. Scrape all dirt from cover plate and remove all old gasket material.

2. Clean cover plate and metal carrier in all purpose lubricating oil. Refer to Service Data for oil part number.

3. Inspect the felt wick lubricators. Wicks with excessive edge rounding, taper, wear, or with hardened, glazed, or burned contact surface, should be replaced with new felt wick lubricators. Normal service tends to pack the upper portion of the wick, which is permissible unless the wick can no longer absorb oil.

4. Clean the felt wick lubricators using all purpose lubricating oil heated to a temperature between 49-60° C (120-140° F). Scrape wick face with putty knife (without digging), clean with a soft bristled brush, or rub wick with an oil soaked rag to remove surface dirt layer. Refer to Service Data for oil part number.

CAUTION

Do not use kerosene, petroleum spirits, chlorinated solvents, or any other solvent to clean felt wicks because the solvent fails to remove embedded dirt and because of the difficulty in removing the cleaning agent. Deposits of these products may result in diluting oil film during operation

5. Check wick by applying oil and squeezing sides of wick face to cause oil to pool on wick face. Observe how rapidly oil is absorbed back into the wick. If a pool of oil remains on the surface of the wick or is absorbed slowly, it is an indication that the wick surface is clogged by glazing or wear. Wick should be replaced with a new wick.

6. The wick contact surface should be free of major irregularities. Slight depressions are permissible provided the depressions do not extend the full length of the wick.

7. Check contact surface of the wick with a straightedge. If any depression exceeds 3 mm (1/8") or if a regular "saw-tooth" pattern is observed, replace with a new wick.

8. The narrow window type wick should be replaced when contact surface has worn down to within 6 mm (1/4") of the metal wick carrier.

The wick should also be replaced with a new wick when the felt has elongated the rivet holes and is loose in the carrier.

9. Visually inspect the metal wick carrier assembly for warping, distortion, or cracks. Replace carrier if required. Check carrier pins and pinholes. Replace parts if worn more than 0.30 mm (.012") over a new assembly.

10. Check wide window support bearing lubricator spring pressure by placing a weight on the wick assembly as shown in Fig. 19. 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.

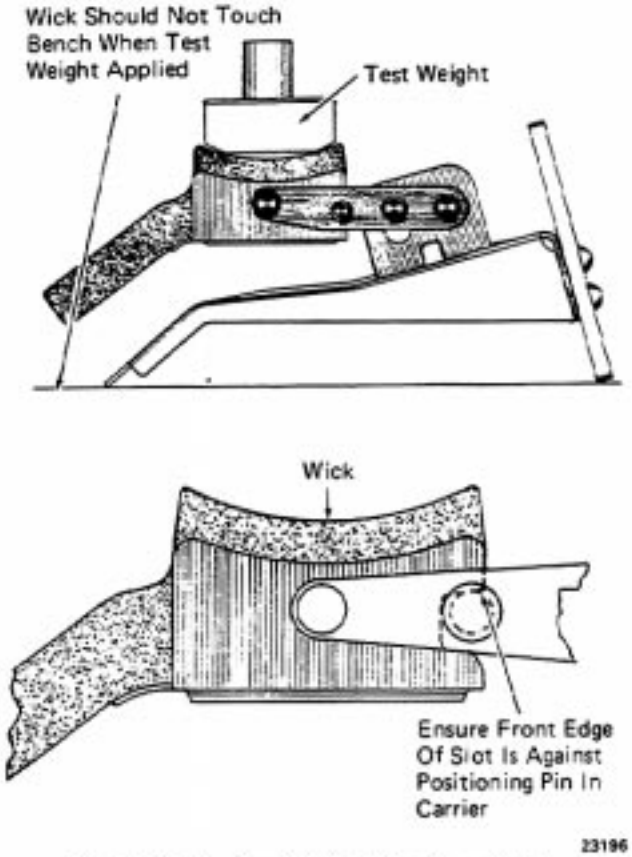


Fig.19 – Testing Wide Window Wick Lubricator Spring

11. Check narrow window support bearing lubricator spring pressure by placing a weight on the wick assembly as shown in Fig. 20. 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.

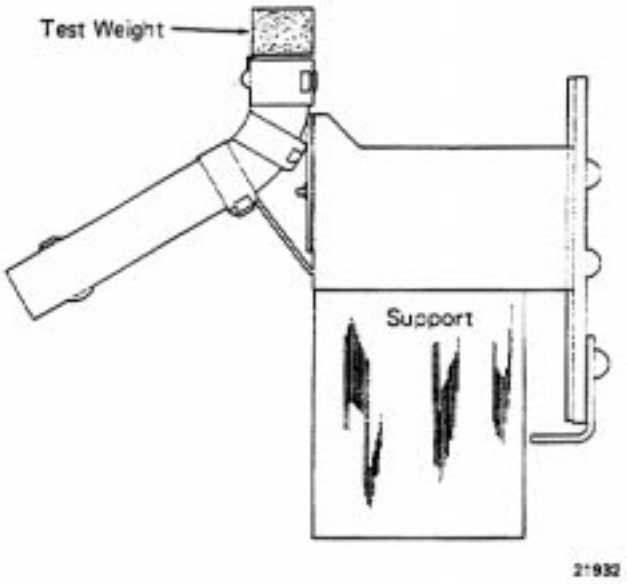


Fig.20 – Testing Narrow Window Wick Lubricator Spring

12. 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.

NOTE

Used wicks must be thoroughly cleaned and impregnated with oil prior to use. New wicks must also be impregnated with oil prior to use.

New replacement wicks are normally oil impregnated prior to shipment from the factory for application without further preparation. However, if wicks have become dry in storage, resoak as instructed in Step 13.

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

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

14. 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 submerged in oil, until oil cools to room temperature.

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

NOTE

Electro-Motive recommends that the wicks be cleaned and soaked using a wick lubricator cleaning machine, if available.

There are many advantages in using a wick lubricator cleaning machine. The machine can be installed adjacent to the area where the wick lubricators are removed, preventing damage to the felt wick and the slides of the carrier due to handling, mistreatment, and water or dirt accumulation. The cleaning machine can also be used for soaking and storage of the wicks. The wick lubricators can be stored in the cleaning machine until just prior to installation.

CLEANING AND SOAKING FELT WICK LUBRICATORS WITH MACHINE

NOTE

Initial road dirt should be removed prior to cleaning operation. Refer to Inspection paragraphs concerning cleaning.

1. Place wick lubricator and carrier in "ferris wheel" cleaning tank as shown in Fig. 21.

2. Allow wicks to rotate in cleaning tank for 4 hours or more at a temperature of 60°-71° C (140°-160° F). Repeat initial cleaning and continue rotating wicks in cleaning tank if wicks are excessively dirty.

3. Submerge wicks in new oil prior to using.

NOTE

Wick cleaning machine can be used to store and soak wicks.

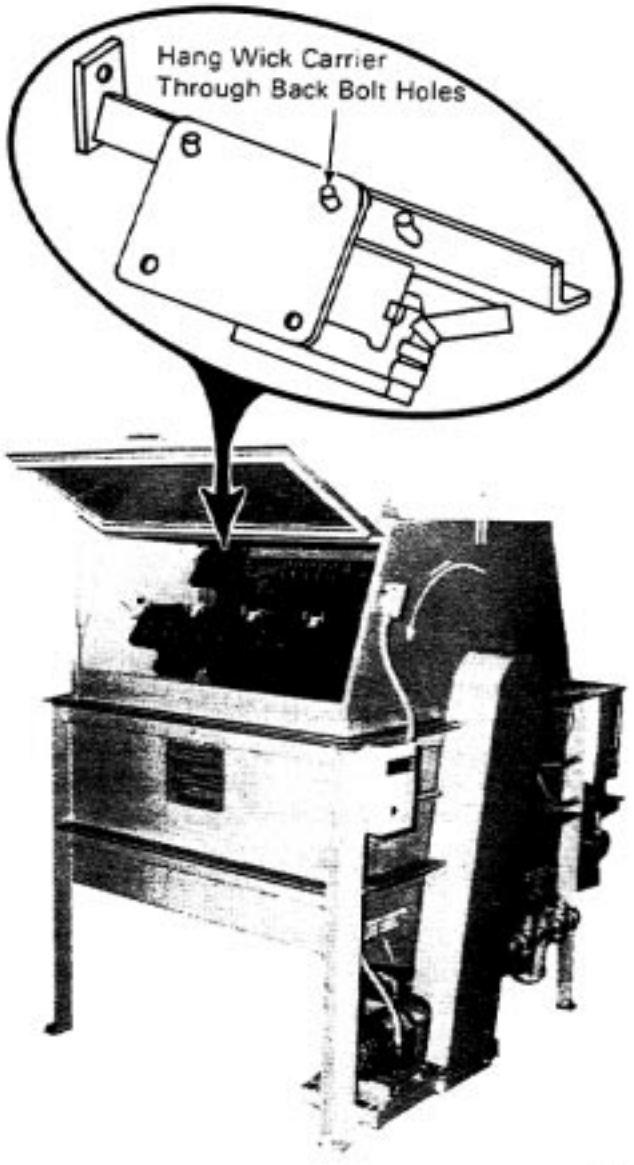


Fig.21 – Wick Lubricator Cleaning Machine

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 by removing clamp.

4. Drain the support bearing cap lubricating oil.

WARNING

When removing the support 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. On dual or single seal support bearings, remove the seal(s) by extending the seal spring and removing spring from notch in seal.

9. To remove the upper half of the support 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 the 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.

   b. The assembled diametrical clearance exceeds 1.17 mm (.046").

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

   d. The maximum axle diameter reduction exceeds 1.6 mm (1/16"). Refer to Replacement Support Bearings paragraphs which follows.

   e. 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. On dual or single seal support bearings, check condition of seals and seal springs. If worn or damaged, replace with new seals.

5. 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.

   Select the best quality bearings for use at the P.E. 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.

8. Poor motor support bearing surface finish at axle journal. Refer to Maintenance Instruction M.I. 1518.

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.

REPLACEMENT SUPPORT BEARINGS

The maximum axle diameter reduction at the support bearings should not exceed 1.6 mm (1/16") due to the axle loading on some locomotives. However, 0.8 mm, 1.6 mm, 2.4 mm, and 3.2 mm (1/32", 1/16", 3/32", and 1/8") undersize support bearings are available for railroads wanting bearings below the recommended minimum undersize of 1.6 mm (1/16"). These undersize bearings have standard size flanges. Refer to Service Data for undersize bearing part numbers.

Bearings are also available with standard bores and 0.8 mm or 1.6 mm (1/32" or 1/16") oversize flange thickness which may be used to keep within the lateral measurements specified. 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 proper lateral dimension. Refer to Service Data for oversize flange bearing part numbers.

Current traction motors are equipped with new FELT LOCK twin seal support bearings. The new bearings, Fig. 22, retain the four groove, dual seal features (seals on inboard and outboard sides) of the former bearings, Fig. 23, and include an improved flange lubricator design that requires no adhesive during installation.

Fig.22 – Current Design Felt-Lock Dual Seal Support Bearing

The new bearings can be used on any model D37 through D87 traction motor provided with the current narrow window wick lubricator and is available as a replacement part. As with previous dual seal bearings, sealing is acomplished by nylon rings that clip onto and rotate with the axle in

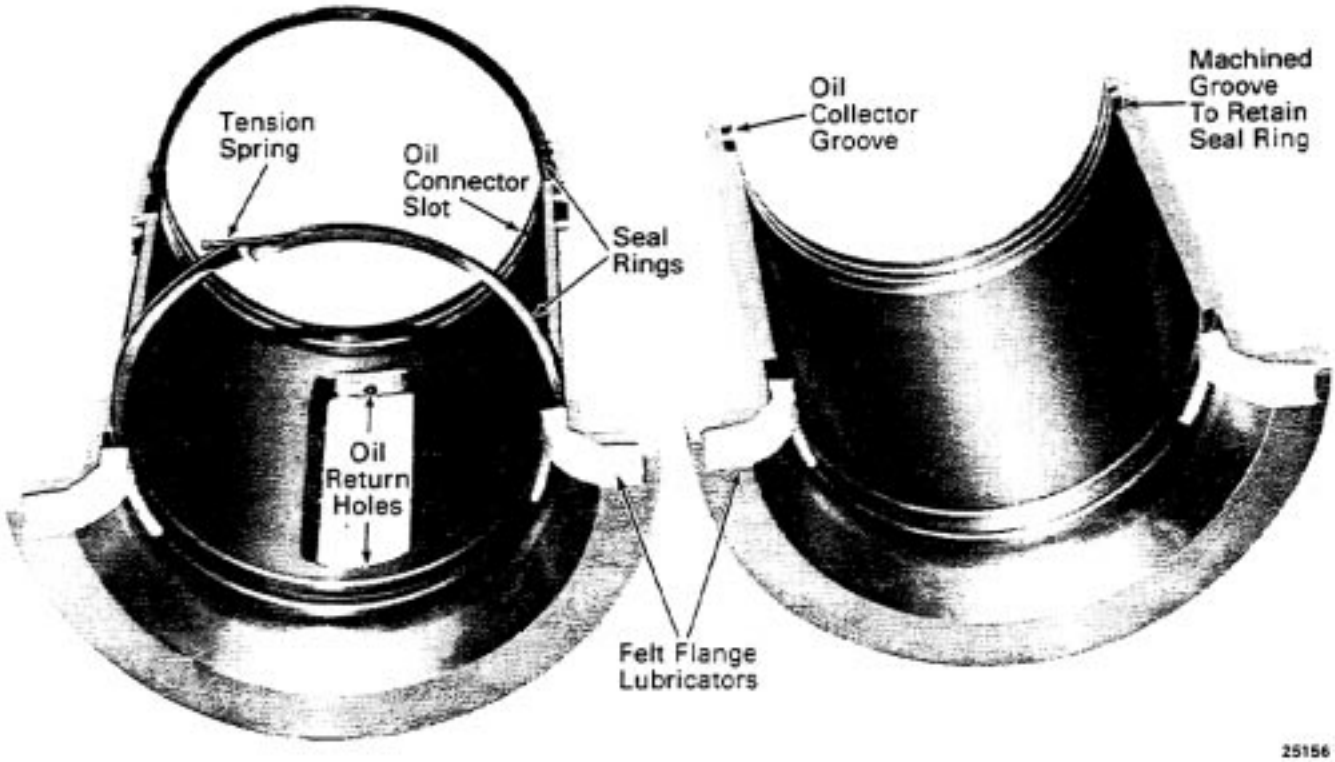


Fig.23 – Previous Design Dual Seal Support Bearing

circumferential grooves machined in the bearing. Oil that would normally flow out of the bearing ends is retained by the seal rings and pumped back to the reservoir through a drilled passage from the seal groove to the wick window. The new dual seal bearing FELT-LOCK flange lubricator wicks are fitted into grooves located in front the bearing split line. These lubricators are not interchangeable with the previous dual seal or the plain bearing flange lubricators. The FELT-LOCK lubricator wick extends out to the bearing flange O.D. The end is sealed to prevent absorbtion of water or entry of dirt.

With the exception that the oil seal rings must be installed before the lower or window half of the bearing is assembled, the bearing installation procedure is unchanged. After the upper bearing half and axle are in place, the seal ring, which is flexible, is spread and threaded into the seal groove and a tension spring is extended and snapped into place. Do not clip the seal rings around the axle before the upper bearing is in place.

INSTALLING MOTOR SUPPORT BEARINGS

1. Ensure all parts are clean, particularily the bearing shells, seats, axles, caps, and seal rings (if so equipped).

2. Check bearing serial numbers. Bearings must be installed in matched sets.

3. Apply recommended lubricating oil to the inside diameter of the bearing shells and to the axle bearing surfaces. Install the upper half of the support bearing.

4. On dual and single seal support bearings, the bearings must have the seal(s) installed before the lower or window half of the bearing is in place.

   a. Spread the seal ring and thread into the 14 mm (9/16") bearing seal groove(s) as shown in Fig. 24.

   b. Extend the seal ring spring and snap in place in notch in seal ring.

5. Install lower half of the support bearing. Ensure bearing shell flanges contact the mating surface on the motor frame to prevent possible lateral movement.

6. Install axle shield over the axle between the two support bearings. The shield serves to prevent dirt from entering the bearing surfaces.

SUPPORT BEARING CAPS

The support bearing caps are machined and line bored to size when mounted on the traction motor with a 0.46 mm (.018") shim inserted between the cap and motor frame. When the motor is mounted in a truck, a 0.25 mm (.010") shim is used in fastening the cap to the frame, Fig. 24, thus giving a 0.20 mm (.008") clamp fit or squeeze to the axle bearing shells. The shim must be installed with cutout side turned out on upper and lower split line, Fig. 24.

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 SUPPORT BEARING CAPS

Current model frames have a 1-3/8"-6 thread for the support bearing cap bolts, eliminating the nut.

Current model support bearing caps have a 152 mm (6") long bolt 9095753 with hardened washer 8495681 at all lower support bearing cap positions. Recent model bearing caps required use of hardened spacers with 6" bolts at lower positions of pinion end support bearing cap only, as shown in Fig. 25. Spacer 9318880 was used with cast frame motors and spacer 9318786 was used with fabricated frame motors. The longer bolt was adopted at that time to provide increased stretch over a former 76 mm (3") bolt 8242193.

The longer 6" bolts and spacers are recommended in areas where the former 3" bolts loosened in service. The increased stretch (2-1/2 times greater) decreases the effect of the initial stretch losses. The longer bolt and spacer is interchangeable with the 76 mm (3") bolt and is torqued to the same value.

Bolts 8135061 and hardened flat washers 8495681 are currently used at all upper support bearing cap positions only. Recent models used these bolts and washers at all upper positions and at the lower positions on the commutator end support bearing cap. The hardened flat washers retain a smoother

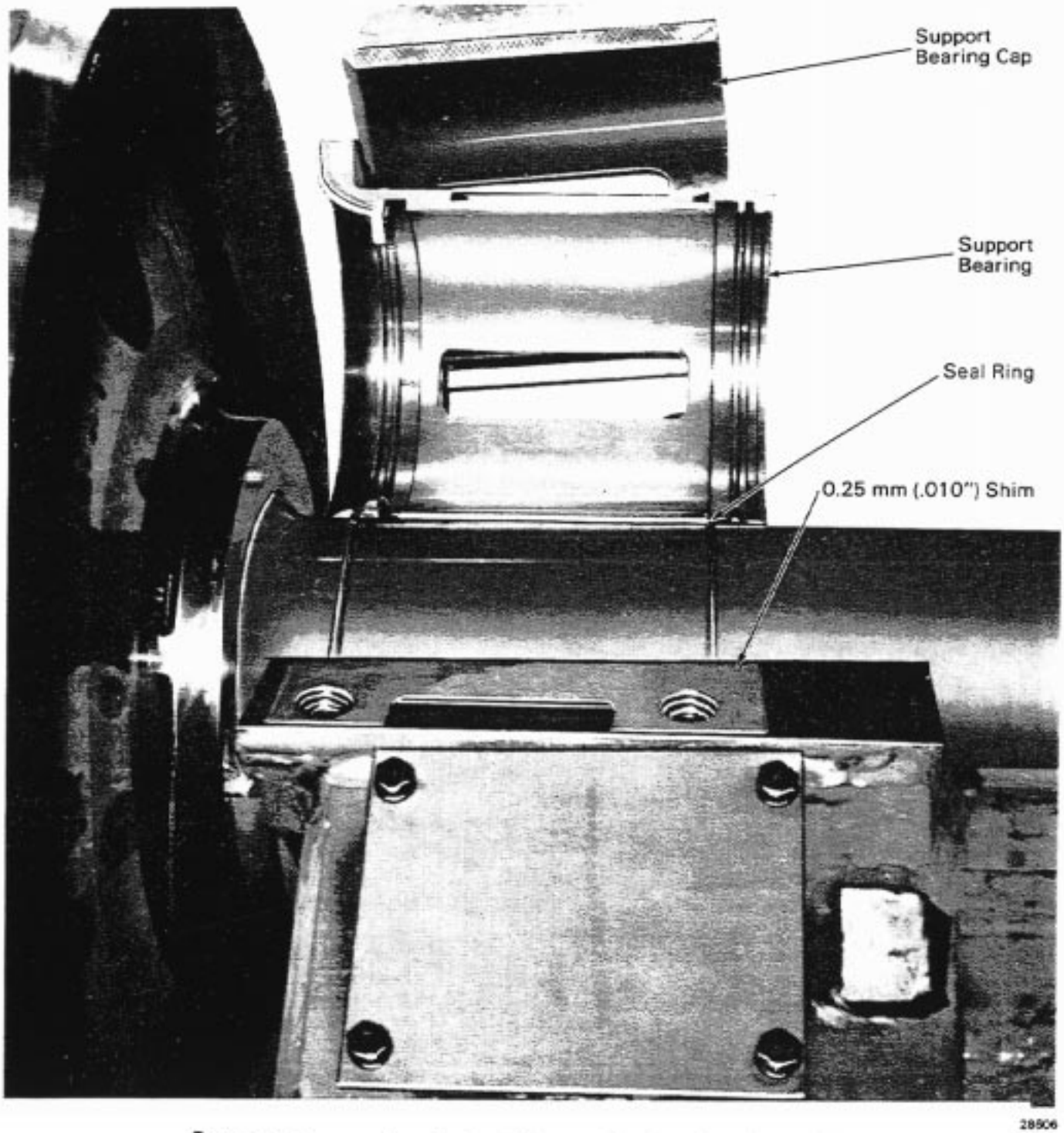


Fig.24 – Support Bearing And Support Bearing Cap Assembly

seating area which results in a higher, more consistent clamp load. The current bolt and flat washer are directly interchangeable with previous bolts and lockwashers. Current bolts have class 3 threads instead of class 5 threads of the former bolts, which used an interference fit.

If the mounting spot face (or machined area) on the support bearing cap is galled, the mounting spot face (or machined area) should be welded and machined to the dimensions of Fig. 26.

CAUTION

Some commutator-end bearing caps are made of ductile iron and cannot be welded. Caps cast of this material will be identified by raised lettering on the reservoir: "DO NOT WELD".

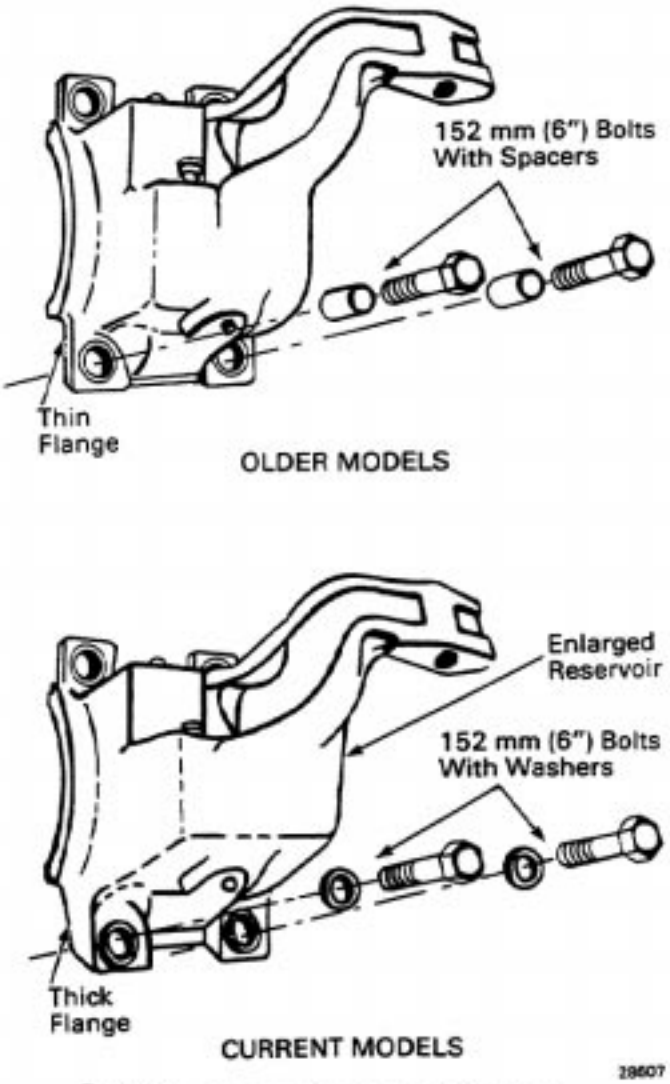


Fig.25 – Lower Pinion End Support Bearing Cap Bolts

The serial number on the support bearing cap and motor frame must correspond with each other.

Install support bearing caps as follows:

1. Install support bearing caps. Apply caps straight as rocking will distort splines and pinch the bearings.

2. Apply a 0.25 mm (.010") shim as shown in Fig. 24.

3. Drive a wedge between the wheel (or gear) and the traction motor frame at the opposite end of the frame to take up clearance and to ensure firm contact between the bearing flange and the motor frame and cap.

4. Install proper washers or spacers and lubricate bolt threads and under bolt head with Texaco Threadtex.

5. Tighten bolts to 1 491 to 1 627 N·m (1100 to 1200 ft-lbs) torque. Ensure cap is not cocked in the motor frame.

6. Check lateral clearance of support bearings to make certain they are within limits shown in Fig. 27.

   a. With support bearing caps tightened, maximum clearance between each bearing flange and corresponding bearing cap is 0.13 mm (.005").

   b. With axle assembly shifted so that wheel hub at end opposite gear end is tight against support bearing flange, minimum clearance between gear hub face and gear end support bearing flange is 1 mm (.040").

   c. A 1.58 mm (.062") thick nylon shim 9524505 is available for use behind support bearing flanges to compensate for worn wheel hubs. Shim may be installed with support bearing in place by spreading it at the split line and threading it between bearing flange and support bearing cap. Shims must not be stacked (more than one) as wick lubricator could interfere with window in support bearing cap.

7. Check radial clearance between support bearings and axle, as shown in Fig. 27.

   a. Remove felt wick lubricator and position axle so that bearing window allows access to the bottom (unloaded) area of the bearing and axle.

   b. Insert a long narrow feeler gauge through the support bearing window, at the center of the window, to a depth of 25 mm to 51 mm (1" to 2") between the axle and the bearing. Radial bearing clearance must not be less than 0.36 mm (.014").

8. The molded rubber dust guard is used to keep dirt and grit out of the support bearing. Check the dust guard for signs of wear, cracks, or deterioration before assembly. Replace dust guard with a new dust guard if required. Install dust guard over the commutator end support bearing flange and the wheel hub and hold in place with steel clamp as shown in Fig. 28.

   Ensure there is good contact between the dust guard and the hub of the wheel. Install dust guard with the two molded buttons of the dust guard mating with the two holes in the support

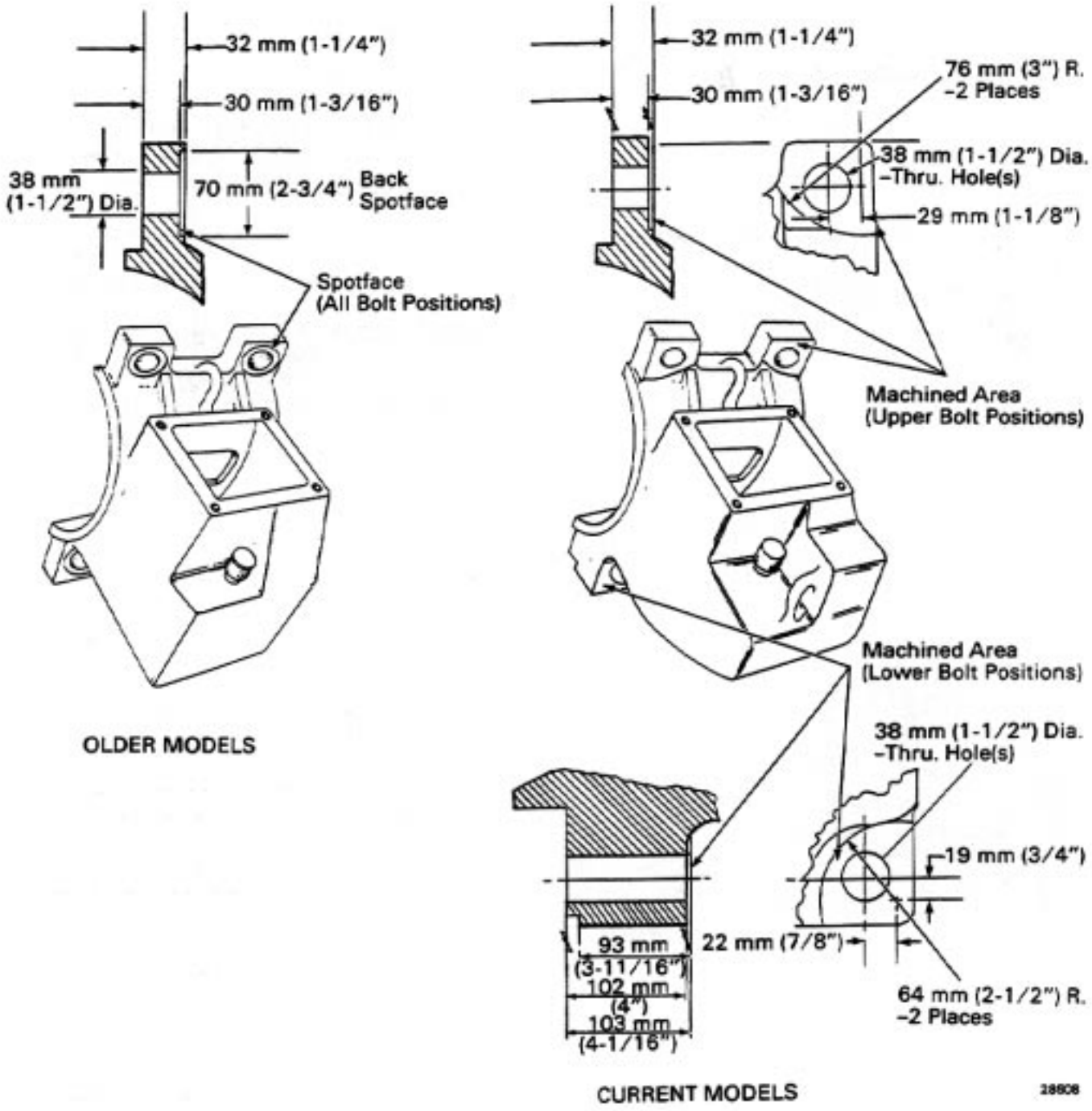
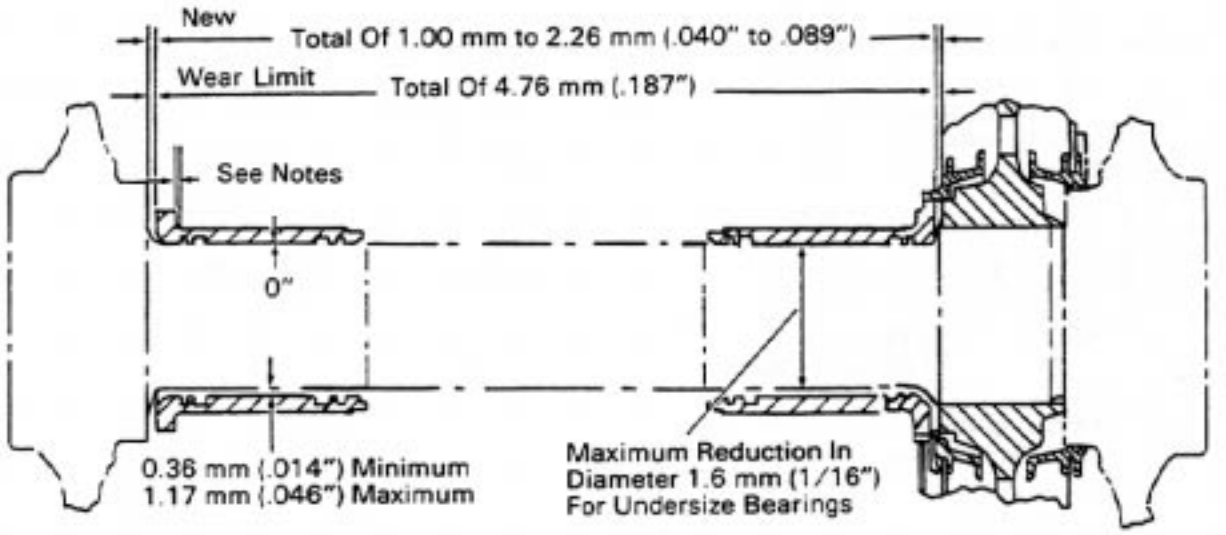


Fig.26 – Support Bearing Cap Mounting Spot Face Remachining

bearing flange and with the split opening of the dust guard (approximately 1/8" wide) located towards the bottom of the traction motor (towards the rail).

9. Apply the previously soaked felt wick lubricator assemblies to the support bearing caps. Ensure wicks are contacting axle surface. Check through the window in the support bearing and the support bearing cap.

10. Pour oil over felt wick lubricators, filling reservoir to proper level with recommended lubricating oil per Maintenance Instruction M.I. 1756.



NOTES

Maximum space between the bearing flange and support bearing cap should be 0.13 mm (.005") with axle cap tightened.

A 1.58 mm (.062") thick nylon shim may be used between the bearing flange and support bearing cap to correct for excessive lateral clearance.

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Fig.27 – Support Bearing Clearances

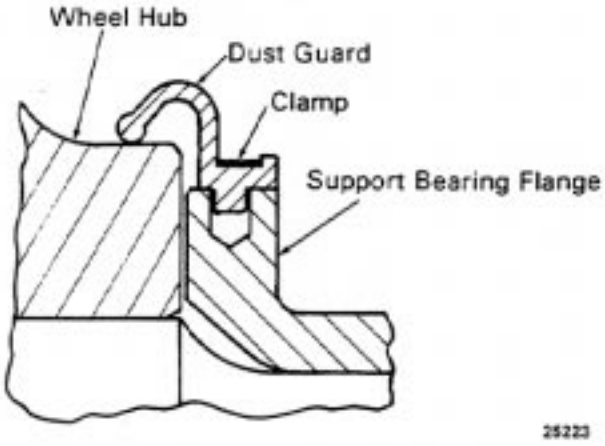

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Fig.28 – Dust Guard Installation

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 motors leads to underframe.

2. Slide the insulating tubes covering 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 by removing clamp.

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. On dual or single seal support bearings, remove the seal(s) by extending the seal spring and removing spring from notch in seal.

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 nose 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. 29. 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.

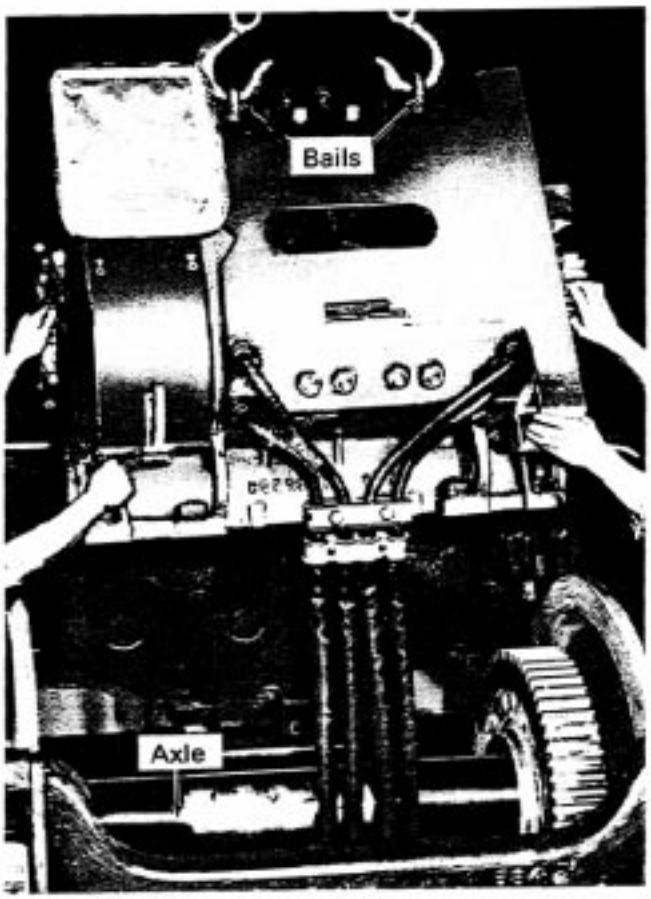

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Fig.29 – Removing Traction Motor

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.

Effective with the D57 traction motor an improved traction motor nose suspension assembly made of resilient rubber pads and steel plates, Fig. 30, was introduced. This assembly is completely interchangeable with the previously used coil springs, and uses the same spring holders, wear plates, pins and bolts.

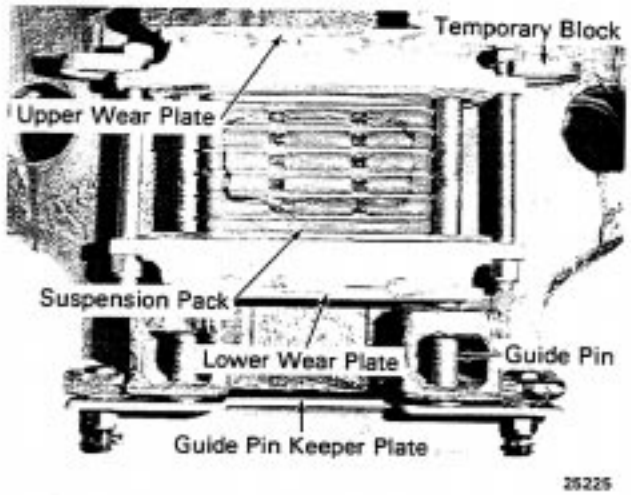

Fig.30 – Traction Motor Nose Suspension Assembly

Current traction motors are equipped with a nose support guide pin that is longer and completely fills the upper guide hole in the truck frame as shown in Fig. 31.

To install the new pin requires the removal of the small metal cover plate that is welded over the upper guide pin hole. The cover plate can be removed by air carbon arc gouging and grinding. Ensure the circumference of the guide pin hole is free of projections. The new pins should be applied in pairs.

The wear plates on the suspension assembly are subjected to severe 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.

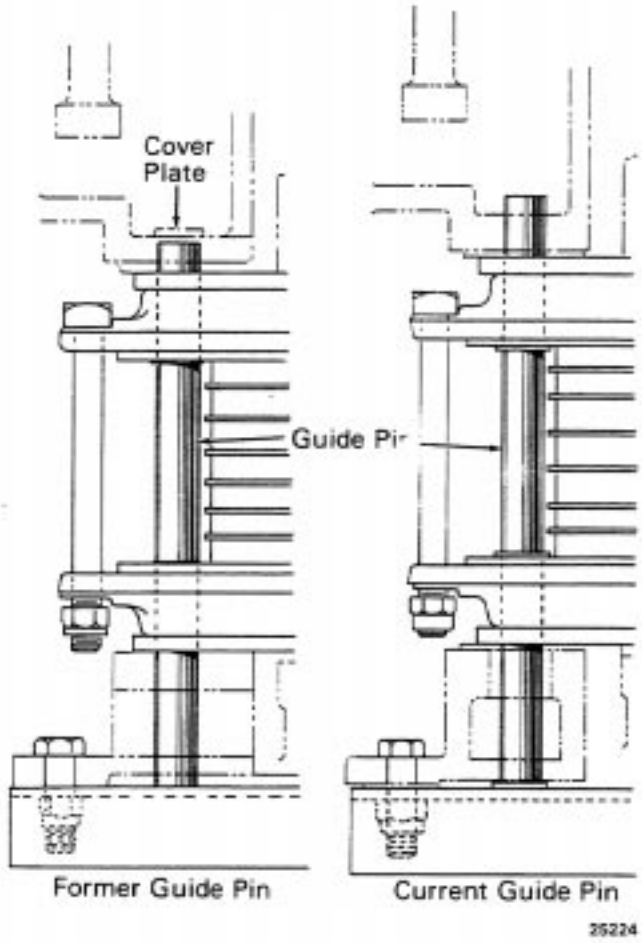

Fig.31 – Traction Motor Nose Support Guide Pin

Traction motor frame assemblies are equipped with manganese steel nose suspension wear plates, Fig. 32.

The nose wear plate on the motor suspension nose on older models is held in place by two 19 mm (3/4") diameter, 102 mm (4") long rivets, and wear plates on current models are welded in place. When a wear plate has worn 2.4 mm (3/32") off its original thickness it should be replaced. Refer to Nose Suspension Lug And Wear Plate Inspection And Replacement Procedure And Wear Plate Welding Procedure which follows. When motor suspension pack wear plates have worn 1.6 mm (1/16") maximum, the plates should be replaced. There should be no wear on the vertical face of the truck transom supporting lugs. If there is, it indicates the lateral clearance in the journal boxes is too great and the journal boxes should be shimmed. Refer to Maintenance Instruction M.I. 1552 for journal box information.

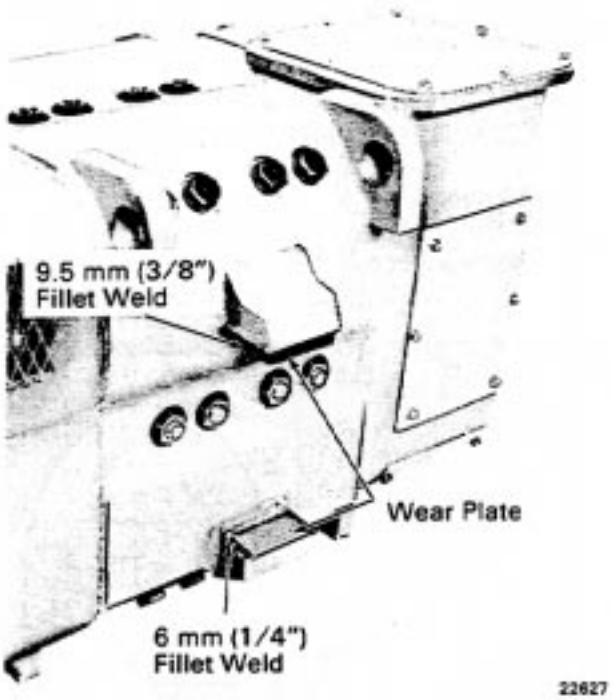

Fig.32 – Traction Motor Nose Suspension Wear Plates

NOSE SUSPENSION LUG AND WEAR PLATE INSPECTION AND REPLACEMENT PROCEDURE

If the distance between wear plate and lower suspension lug machined surface is more than 307.18 mm (12-3/32"), refer to Fig. 33 and perform the following procedure.

1. Check the lower suspension lug dimension from horizontal centerline of motor. If dimension is greater than limits of Fig. 33, area should be milled to dimension of Fig. 33 and a 6.35 mm (.250") wear plate welded to suspension lug. Refer to Wear Plate Welding Procedure which follows. It is not necessary to maintain the 45° chamfer on lower suspension lug as shown in Fig. 33, but maintain the 374.6 mm (14-3/4") dimension from vertical centerline of motor as shown in Fig. 33.

2. If the lower suspension lug is within tolerance, the 19.05 mm (.750") upper suspension lug wear plate must be replaced. If upper suspension lug is undersize, build up with weld and re-machine to dimension of Fig. 33. Use only A.W.S. E-7016 stick electrode. Refer to Wear Plate Welding Procedure which follows.

NOTE

Upper suspension lug is not a normal wear area, but if for any reason such as a loose wear plate pounding the lug, the suspension lug must be welded and re-machined.

WEAR PLATE WELDING PROCEDURE

The proper preparation of motor frame surface is very important to successful application of the wear plates. The frame surface must be smooth and flat. Remove any weld beads or high spots. If the nose bracket face dimension is not within tolerance of Fig. 33, the surface must be welded and re-machined. Perform the following procedure to install wear plates if required.

1. Position wear plates on frame and hold in place with a hydraulic jack which exerts a force of 4.5 to 7.3 tonnes (5 to 8 tons).

2. Check wear plate fit to frame with a 0.08 mm (.003") shim. Shim should not enter more than 13 mm (1/2") at any point between the frame and the pad. Excess gap can cause weld to fatigue.

3. Weld wear plates to frame using E-Fe-Mn-A welding electrode. Ensure good penetration is obtained on both the frame and the wear plate.

4. Allow weld to cool for a few minutes before removing jack. Check the plate fit to frame with a 0.08 mm (.003") shim.

5. Check the distance between the wear plates. The distance should be a nominal 306.70 mm (12.075").

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 12 teeth to 25 teeth depending upon installation. The traction motor with a 12 tooth pinion is referred to as an "E" model. Since the diameter of 12 tooth pinion is small, it is made integral with the armature shaft; all other pinions are removable.

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.

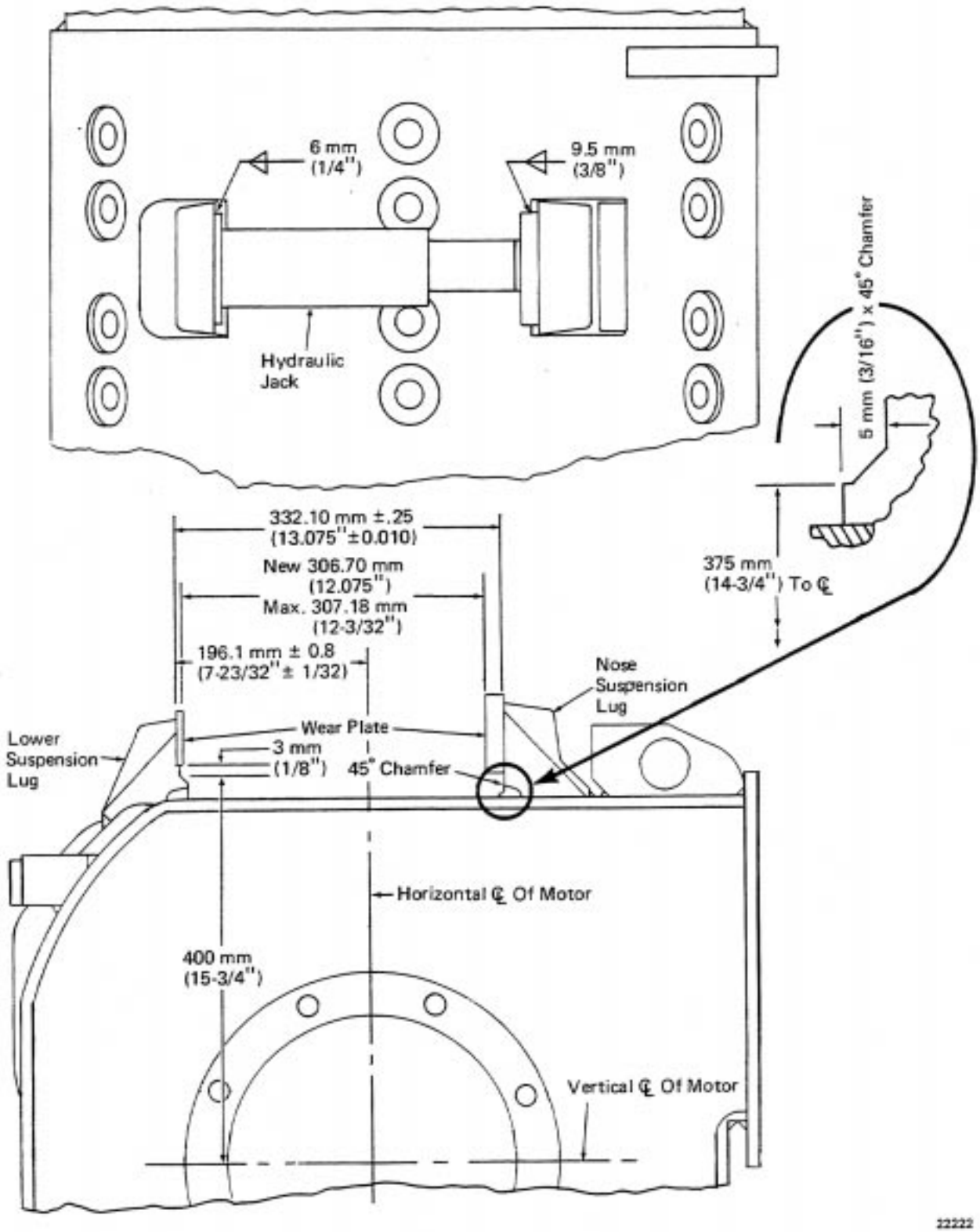

Fig.33 – Nose Suspension Lugs And Wear Plates

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. 34, or with an air impact wrench.

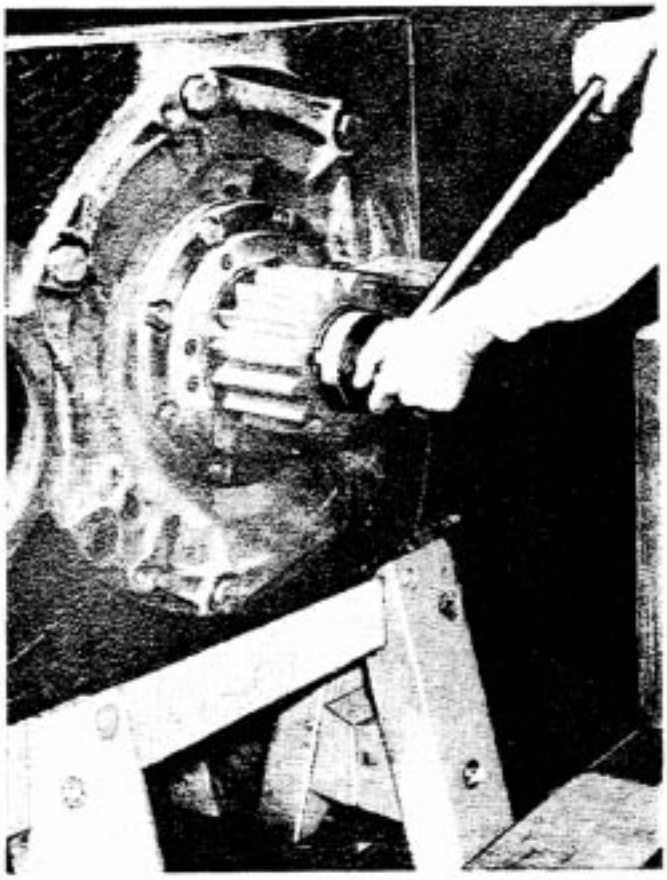

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Fig.34 – Removing Pinion Retaining Nut

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. 35, using a suitable hoist. The threaded pilot should enter the threaded portion of the pinion to its complete depth so threads will not strip.

WARNING

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

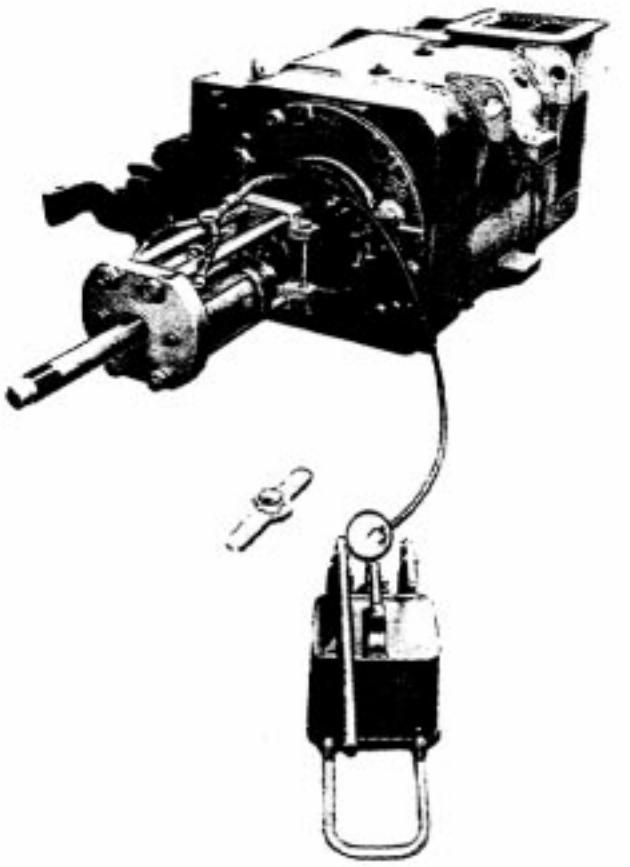

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Fig.35 – Hydraulic Pinion Puller

Clear area in line with pinion to avoid damage to equipment or injury to personnel when 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 the inset of Fig. 36. 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.

NOTE

The D87 traction motor requires a pinion advance on the shaft greater than the advance of earlier model motors. The increased assembly pressure requires higher pressure for hydraulic removal of the pinion. A pinion removal kit containing high pressure steel tubing rather than a hose assembly is available. The high pressure steel tubing can also be used

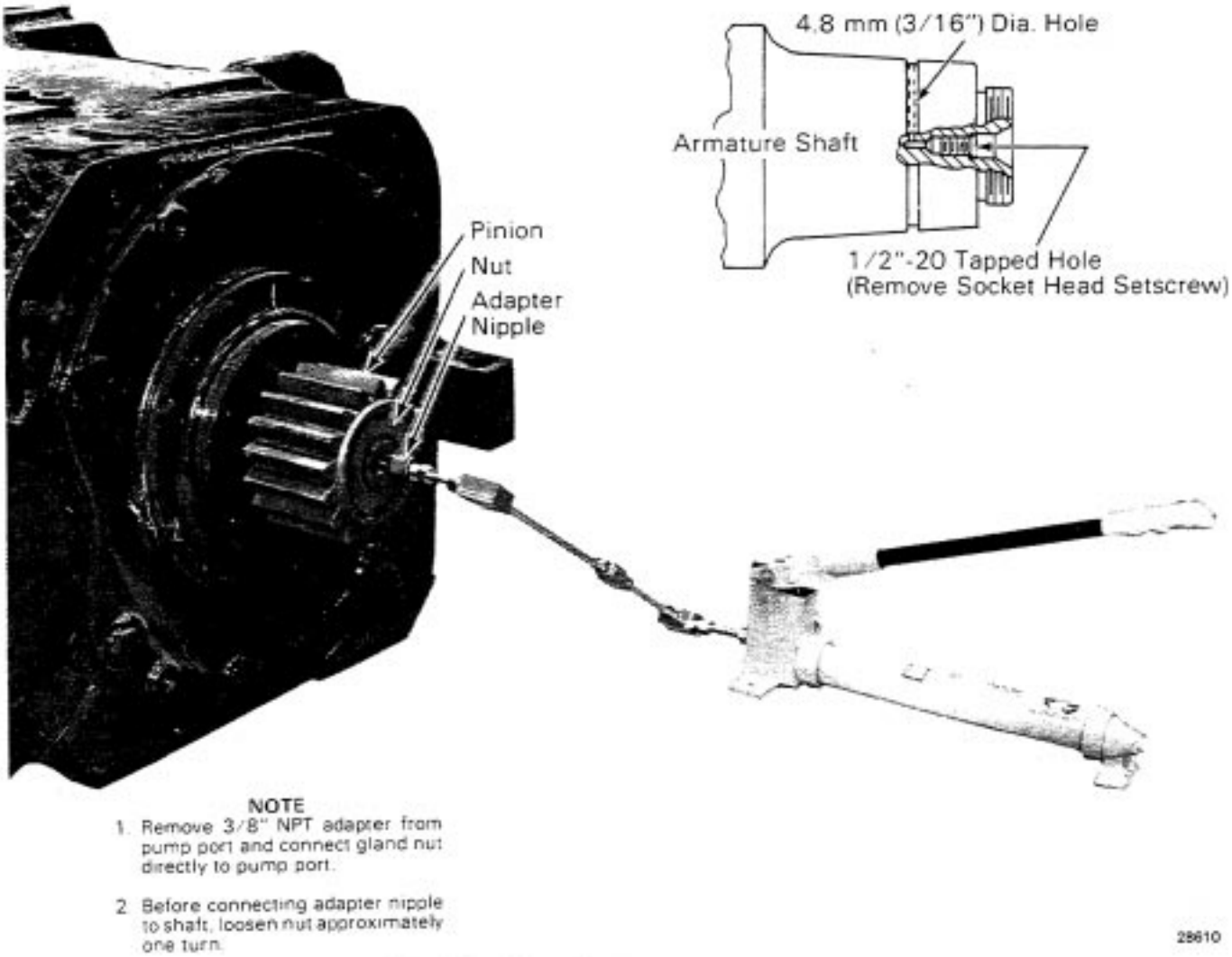


Fig.36 – Float-Off Pinion Removal

for removing pinions from earlier model motors. The lower pressure pinion removal kit is discontinued.

Refer to Service Data for the hydraulic pinion removal kit part number. The pinion is removed as follows:

1. Loosen the nut on the end of the armature shaft with a retaining nut wrench and handle, Fig. 34, or with an air impact wrench approximately one turn, or 3.18 mm (1/8").

WARNING

Retaining nut must remain on the armature shaft when attempting to remove pinion. Pinion will release suddenly which could cause personal injury and damage to pinion removal equipment if nut is not in place.

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 the hydraulic pump 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 hydraulic pump gland nut (with sleeve) to the pump port as shown in Fig. 36. Close valve on pump and operate pump lever to build up pressure. When pump pressure becomes great enough, pinion should be released from armature shaft and should move off against the pinion retaining nut.

   If the pinion is frozen to the shaft and will not release, a hydraulic puller may have to be used as an aid to removing pinion. Apply hydraulic pressure to shaft and apply pulling force simultaneously.

5. Remove equipment, remove pinion retaining nut, remove pinion and replace setscrew in the end of the armature shaft and tighten to 16.9 N·m (150 in. lbs)

NOTE

Setscrew has nylon plug insert in threads to retain torque. Typical minimum breakaway torques to qualify screw for reuse should be 2.5 N·m (22 in. lbs) after the first time off or 1.7 N·m (15 in. lbs) after the fifth time off.

PINION APPLICATION

It is essential that the pinion be properly mounted on the armature shaft to ensure it is fit with the proper tightness.

The shaft and the pinion should be at room temperature, approximately 21° C (70° F). A maximum of 5.5° C (10° F) temperature differential between the shaft and the pinion should be allowed.

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 with Grade 320 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 by hand. 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.

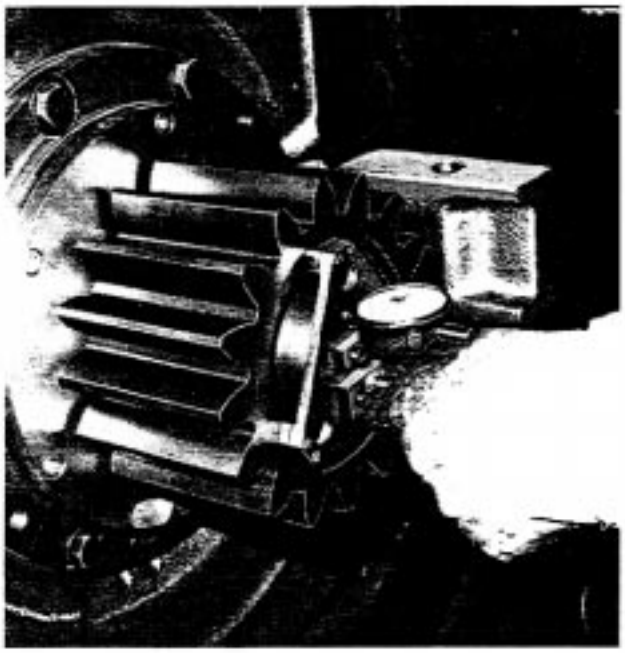
      It is necessary that the pinion make firm contact with the small end of the armature shaft taper. A 50% contact is expected, but if the two tapers are at opposite extremes of tolerance, it is required that the pinion make firm contact with at lease 20% at the small end of the armature shaft taper. The large end of the bore should not make 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 with Grade 320 abrasive cloth.

   d. Thoroughly clean and remove all traces of bluing from 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. 37.



27061

Fig.37 – 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 reapplying 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 exceeeds 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 make firm contact with at least 20% at the small end of the armature shaft taper. The large end of the bore should not make contact unless a line-to-line contact is obtained through the bore.

11. When cold mounting variations are within limits, the pinion may be heated with an induction heater, Fig. 38, for final mounting. Heat and mount the pinion as follows:

NOTE

In Step a following, 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 9 months if stored at temperatures below 24° C (75° F). Reduced stability will result if the cleaner is stored at higher temperatures.

WARNING

Avoid excessive or prolonged inhalation of liquid cleaner mists or dust. Avoid eye contact and repeated or prolonged skin contact. Liquid cleaner can cause eye and skin irritation.

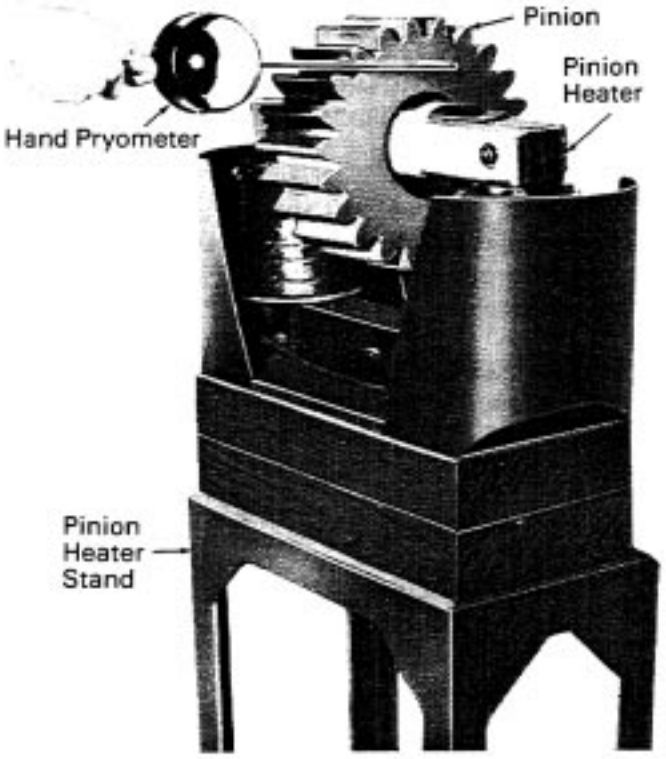


Fig.38 – Induction Heater

a. When applying 15-tooth or smaller pinions and model D87 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 suface with 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, then 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 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 232° C (450° F).

NOTE

Since a change of 1° C is equivalent to a change of 1.8° F, a 189° C rise in temperature is therefore equivalent to a rise of 340° F.

As an example of proper model D87 heating, assume the shaft temperature is 24° C (75° F). The pinion should then be heated to obtain 213° C (415° F), which is the desired 189° C (340° 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 following, 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. On previous model motors with soldered connectors, inspect solder at top of the connector for cracks or visible solder distress. On current motors with crimped connectors, ensure connector is firmly crimped to the cable by bending cable and pulling connector.

4. Check grommets for deterioration, cracks, wear. Ensure grommets are not loose in 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 cable as follows. Refer to Service Data for grounding cable and heat shrinkable tubing part numbers.

   a. Attach grounding cable as shown in Fig. 39.

   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. 39.

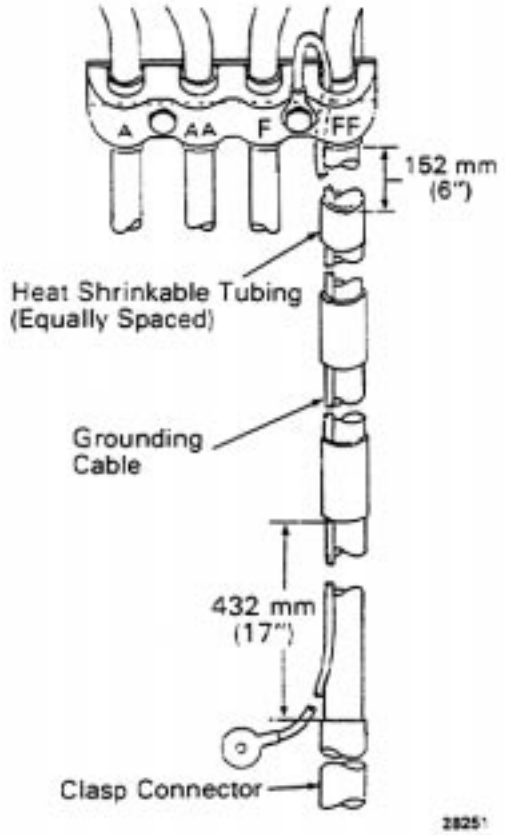


Fig.39 – External Lead Grounding Cable Application

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

CRIMPING CLASP CONNECTORS TO CABLE LEADS

Current D87 series traction motors have the clasp connectors crimped to the motor leads. Prior to this, D37 through D77 motors and early model D87 motors had soldered connectors. If the connectors and/or motors leads are to be replaced on any early or current model D87 motor, EMD recommends that only crimp type connectors be used to facilitate application and improve connection.

In the following procedure, operation of an AMP, Inc. electro-hydraulic crimping tool, Fig. 40, is used with clasp connectors supplied by AMP, Inc. If another type of crimping tool is used (which can accomplish equivalent results), this procedure can be used as a guide.

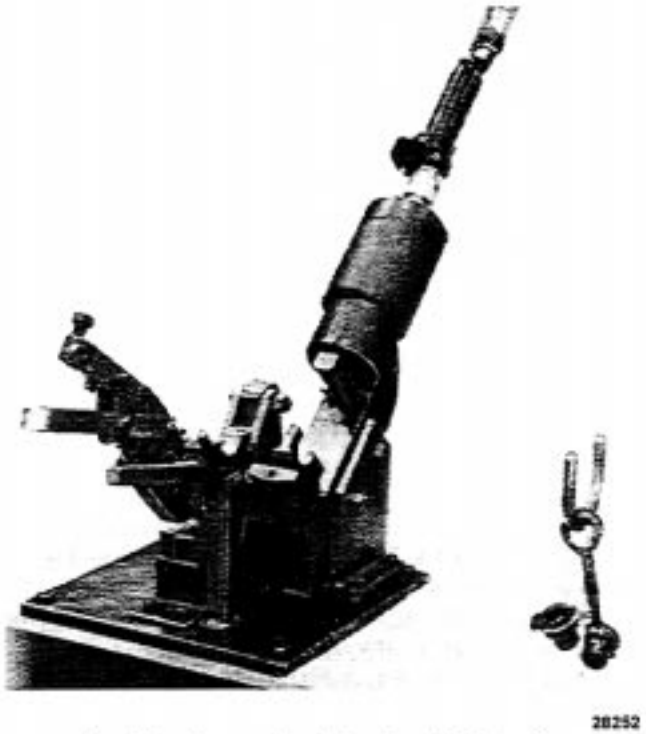


Fig.40 – Amp, Inc. Electro-Hydraulic Crimping Tool

The crimps are to be made at a 45° angle to the flat face of the clasp connector. The crimps are to be made between the crimp marks on the connector barrel.

1. Strip 44-47 mm (1-3/4" to 1-7/8") of insulation from clasp connector end of cable. Ensure cable is clean and not frayed.

2. Apply clasp connector to the end of cable. Ensure cable is bottomed against the shoulder of the connector.

3. Position clasp connector in crimping machine, as shown in Fig. 41. Ensure end of clasp connector is up against the first stop of the fixture.

4. Swing the holding block over onto the connector and lock in place as shown in Fig. 42.

5. Operate crimping machine and make the first crimp in the clasp connector. Fig. 43.

6. Unlock holding block and position clasp connector against the other stop for the second crimp, Fig. 41. Operate crimping machine and crimp as shown in Fig. 43.

7. Check clasp connector crimps. The thickness of the finished crimps should be between 15.04 and 15.67 mm (.592" - .617"). A properly crimped clasp connector is shown in Fig. 44.

SOLDERING CLASP CONNECTORS TO CABLE LEADS

If a crimping tool is not available, D87 series traction motors can have clasp connector 8109922 soldered to the cable using a high temperature solder (89.5% lead, 10% tin, 0.5% antimony). Clasp connectors for D37 through D77 motors may be soldered with a tin base solder (50% tin, 50% lead).

Solder the clasp connector to the cable as follows:

1. To remove the old soldered clasp connector from cable, 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.

NOTE

If completed solder joint shows any sign of visible solder distress, joint should be ultrasonic tested. A joint exhibiting more than 25% void or unbonded area is considered to be defective.

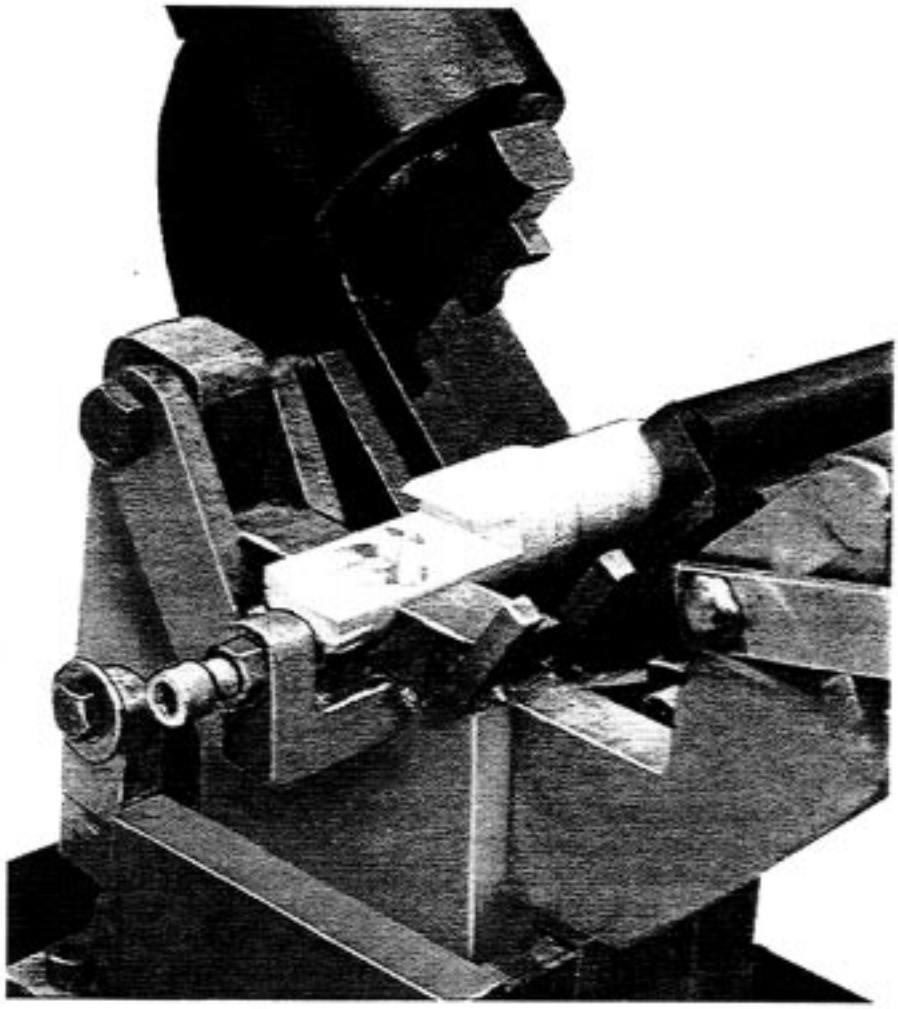
If insulation near the lug splits as a result of rework, apply heat shrinkable tubing over the split.

SUPPORT BEARING MOISTURE SEAL

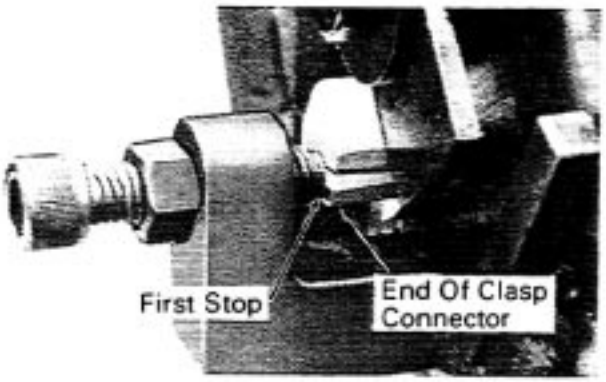
Railroads experiencing accumulation of moisture in support bearing oil reservoirs can relieve the condition by applying a bead of RTV silicone compound at the traction motor support bearing cap split line and at the edges of the axle shield as indicated in Fig. 45.

During severe weather, water with entrapped dirt can enter the traction motor axle cap bearing area from behind the support bearing flange, where a gap of up to 0.13 mm (.005") is possible at assembly. The moisture migrates around the back side (seating area) of the support bearing into the axle cap wick window and accumulates in the bearing oil reservoir.

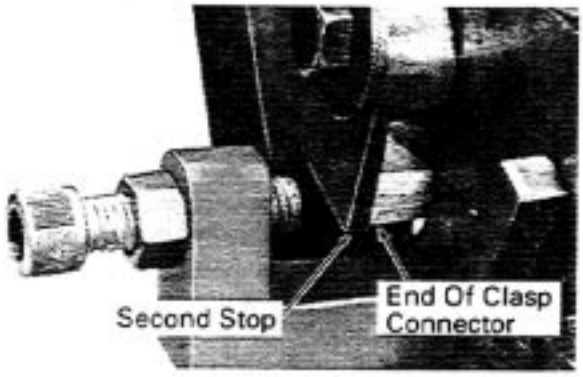
Since September 1982, silicon rubber sealant 8366747 (RTV) has been applied between the support bearing flange back side and the traction motor frame and axle caps. The sealant forms a circular seal in addition to the seal that has been applied for many years at the axle cap split lines and the axle shield. The additional sealant greatly reduces the possibility of moisture and dirt entry, thereby contributing to increased lubricating wick and support bearing life.



28253A

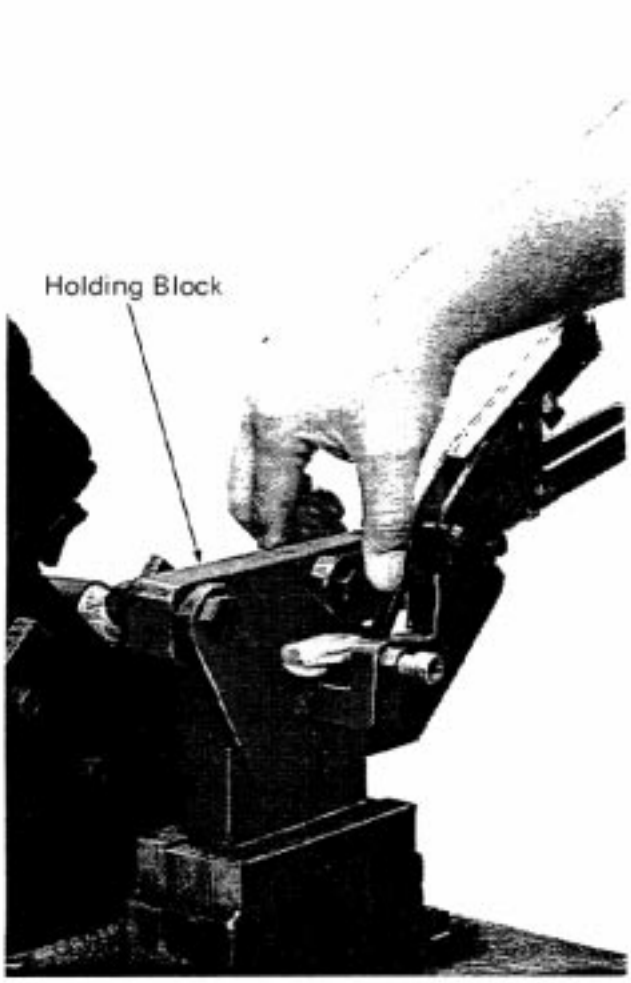


28253B

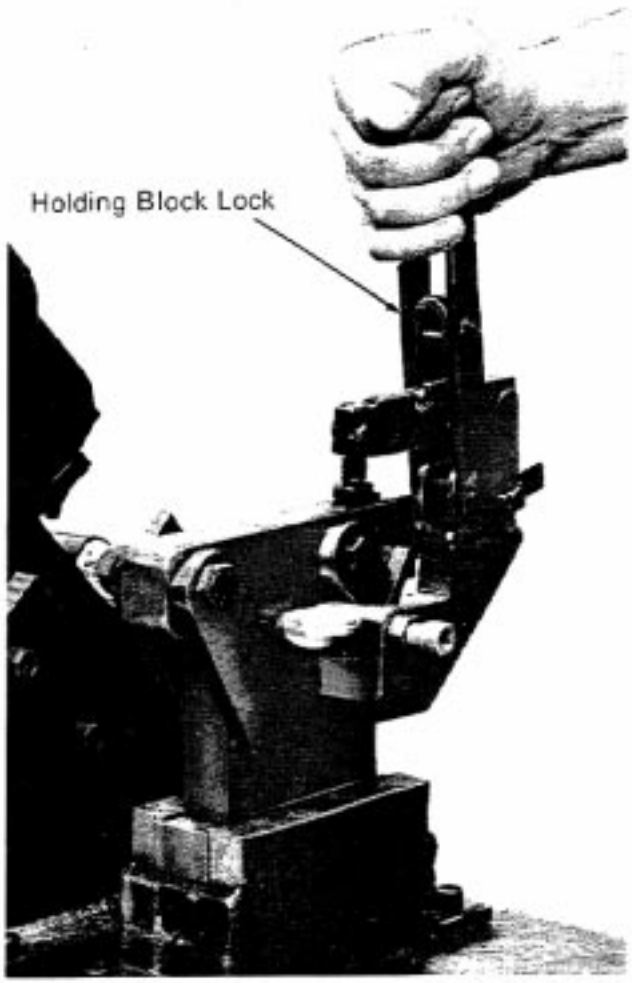


28253C

Fig.41 – First And Second Crimp Positions

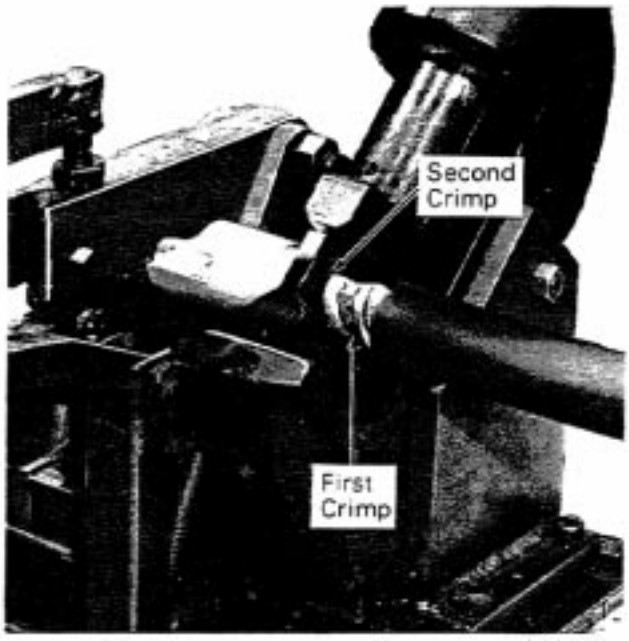


28254



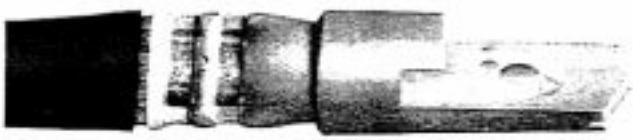
28255

Fig.42 – Locking Clasp Connector In Position



28256

Fig.43 – Crimping Clasp Connector



28257

Fig.44 – Properly Crimped Clasp Connector

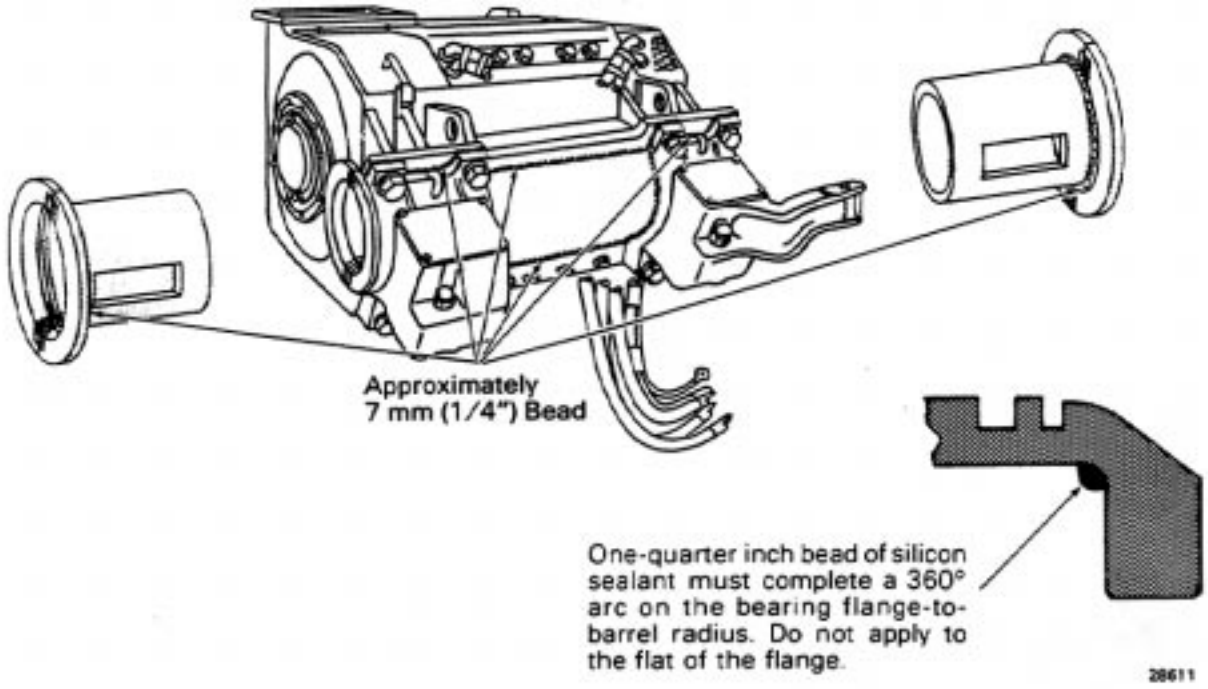


Fig.45 - Application Of Silicon Rubber Sealant

Oil residue must be removed from all sealing surfaces by wiping with a solvent before applying sealant. The sealant between the support bearing flange and motor frame must be applied at assembly of the bearing to the frame. A 7 mm (1/4") bead must complete a 360° arc on the bearing flange-to-barrel radius, Fig. 45.

CAUTION

Application of sealant directly to the flat of the flange can interfere with seating of the bearing in the frame and prevent an acceptable flange-to-frame gap (0.13 mm [.005"] maximum).

The other seams and split lines are sealed after the traction motor is mounted on its axle, and the axle shield and caps are secured.

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 support bearing 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 has a threaded metal base and a hinged flip top. The hinged top is susceptible to broken hinges and leakage.

The new cap, Fig. 46, is 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.

CHECKING TRACTION MOTOR ROTATION

On "E" and "DD" type locomotives (except DDM45), each truck may be checked individually by isolating the power plant not being tested. Switchers can similarly be checked by using the truck cutout switch.

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

The wiring differences between the older motors and the current configurations is the connection between the "A" lead and the brush holder, and the connection between the interpole and the brush holder, Fig. 47. Some older models are recabled to the lastest wiring diagram when rebuilt by EMD.

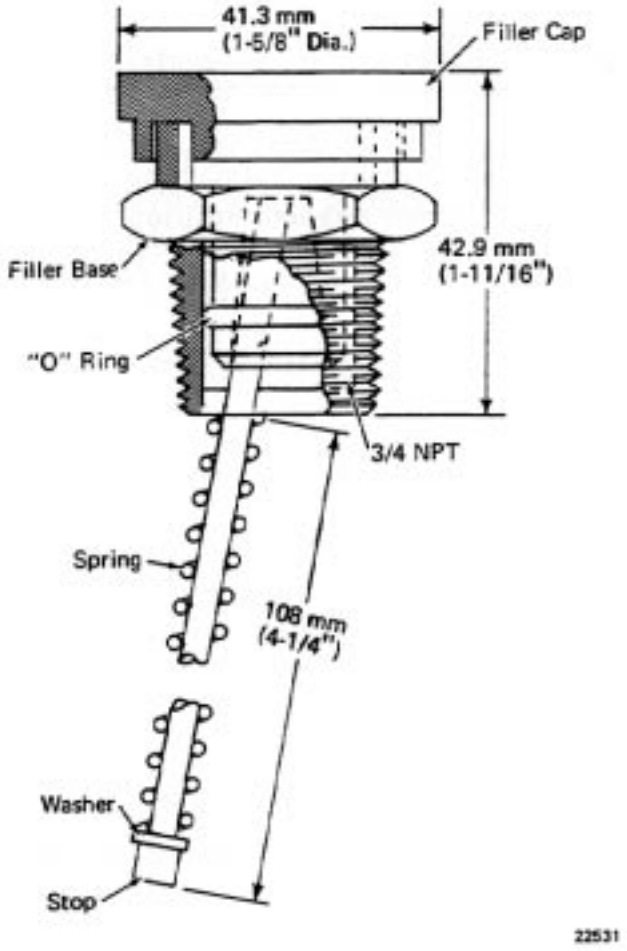


Fig.46 - Support Bearing Oil Filler Cap

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 on motor rotation, may be observed.

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

ELECTRICAL TESTS

STATOR RESISTANCE AND POLARITY CHECK

1. Install brush holders if removed. Ensure contact areas between brush holders and terminals are clean and tight.

2. Measure the resistance of the main field and interpole coil circuits with a Kelvin bridge. Check temperature with thermocouple probe and potentiometer as follows. Refer to Fig. 47.

   a. Place thermocouple probe onto one of the coils in the stator.

   b. Connect the current and potential leads of the Kelvin bridge to the "FF" and "F" cables of the stator and take resistance readings of the main field circuit. Record readings.

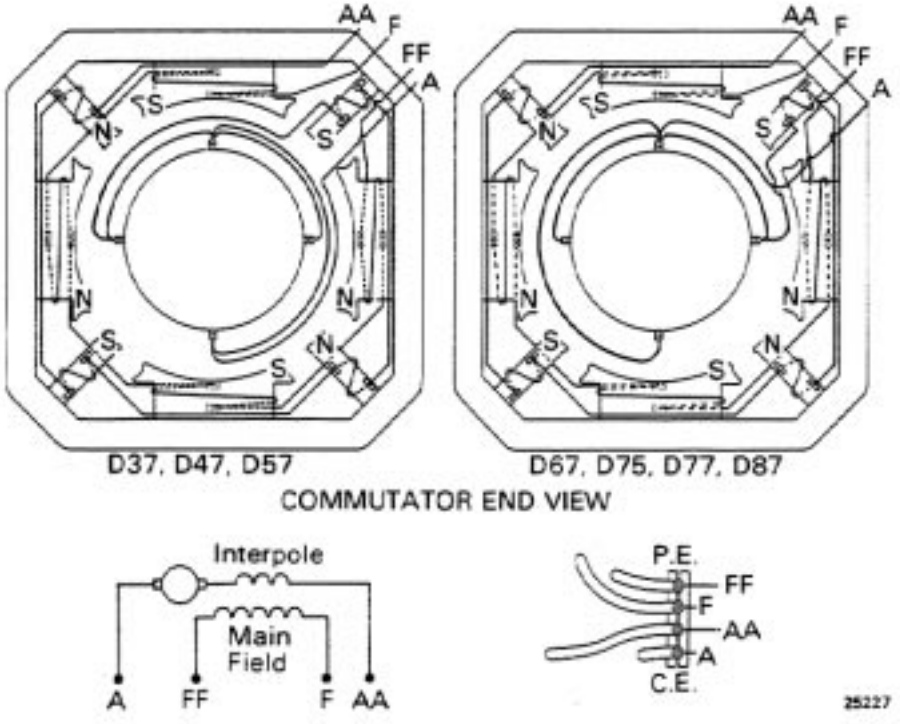


Fig.47 - Wiring Diagrams

c. Connect the Kelvin bridge to the "AA" cable and to the axle side brush holder and take resistance readings of the interpole circuit. Record readings.

NOTE

Ensure the bridge is connected between the end of the "AA" cable and the axle side of the brush holder. If connection is made to the suspension side of the brush holder, the resistance will be out of tolerance.

d. Check and record temperature indicated on the potentiometer.

The resistance values of the circuits when readings are converted to 75° C (167° F) should be as specified in the Service Data by model number.

NOTE

The following formula can be used to convert resistance under ambient (room temperature) conditions to a nominal resistance at 75° C (167° F):

$$\text{"R" @ 75° C (167° F)} = \text{"R" @ Ambient} \times \frac{75 + 234.5}{\text{"T" @ Ambient} + 234.5}$$

"R" = Resistance "T" = Temperature

If the readings are higher than those specified, inspect all connections. It is necessary in most cases to check each individual coil to determine which coil is defective. Split the circuit to determine the "low side" before opening all the connectors between the coils.

If the readings are lower than those specified, a short is indicated. Individual readings of each coil should be taken to determine that the coils balance.

If the resistance is satisfactory, polarity may be checked to determine that the coils are properly located in their magnetic position. Using a low voltage DC power supply and a compass, check the polarity as follows. Refer to Fig. 47.

1. Connect low voltage DC power supply to external cables "F" (negative) and "FF" (positive).

2. Hold the compass at the center of the top main field coil. The compass should indicate a south pole reading. Move compass from pole to pole. Each pole should indicate a definite change in polarity on the compass. If the compass does not indicate a definite change in polarity, two poles of the same polarity are positioned next to each other or there is a wrong connection at the connector bars.

3. Check the interpoles in the same manner, connecting the low voltage DC power supply to the "A" cable and to the axle side brush holder of the stator.

4. If there is evidence of a wrong polarity in either the main or interpole circuits, the defective coils or connections will have to be corrected to obtain proper motor performance.

ARMATURE RESISTANCE

Check armature resistance. Measure temperature with thermocouple probe and potentiometer on commutator.

The armature resistance at 75° C (167° F) should be as specified in the Service Data by Model number.

SERVICE DATA

REFERENCES

Wheels, Axles, Axle Gears And Pinions	M.I. 1518
Traction Motor Gear Case Inspection And Repair	M.I. 1520
Application Of Cyprina – RA Grease To Motor Armature Bearings	M.I. 6850
Gear Case Modification And Application Of Plastic Gear Case Seals	M.I. 9656

SPECIFICATIONS

WEIGHTS (Approximate)

	D87	Others
Complete Motor	2 912 kg (6420 lbs)	2 790 kg (6150 lbs)
Armature	872 kg (1923 lbs)	821 kg (1810 lbs)
Gear Case	68 kg (150 lbs)	68 kg (150 lbs)

RESISTANCE AT 75° C (167° F)

Armature	
D37, D47, D57, D67 & D75	0.01446 ohm ± 2%
D77	0.01232 ohm ± 2%
D87	0.01190 ohm ± 2%
Main Field	
D37	0.00975 ohm ± 2%
D47, D57, D67, D75 & D77	0.00876 ohm ± 2%
D87	0.00797 ohm ± 1.5%
Interpole Field	
D37	0.00751 ohm ± 2%
D47, D57, D67, D75 & D77	0.00652 ohm ± 2%
D87	0.00635 ohm ± 2%

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

	Part No.
Coil Spring Adjustable Type Holder (D37, D47, D57)	
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
Grade AC-137	*9561482
Two wafer, flat top 56 mm x 51 mm x 16 mm (2-3/16" x 2" x 5/8") Grade DE-7	*9322056
*Multiple Wear Lines	
Constant Pressure Type Holder (D37, D47, D57)	
Two wafer, with resilient pad 56 mm x 51 mm x 16 mm (2-3/16" x 2" x 5/8") Grade DE-7	*9322054
Grade AC-124	*9322053
Grade AC-137	*9561481
*Multiple Wear Lines	
Three wafer, with resilient pad and floating center wafer 54 mm x 51 mm x 16 mm (2-1/8" x 2" x 5/8") Grade DE-7	8403347
Constant Pressure Type Holder (D67, D75, D77, D87)	
Two wafer, with resilient pad 62 mm x 51 mm x 16 mm (2-7/16" x 2" x 5/8") Grade AC-100	*8394852
Grade AC-137	*9561483
*Multiple Wear Lines	
Three wafer, with resilient pad and floating center wafer 62 mm x 51 mm x 16 mm (2-7/16" x 2" x 5/8") Grade AC-124	*9322057
Grade DE-7	*9322058
Grade AC-100	*9322059
Grade AC-137	*9541558
*Multiple Wear Lines	
Brush Wear Limit	Replace when spring pressure arm is 3 mm (1/8") above brush box

SERVICE DATA (Cont'd)

COMMUTATOR

Mica Groove Width	
D37, D47, D57, D67	0.84 mm (.033")
D75, D77, D87	1.27 mm (.050")
Mica Groove Depth	
Minimum	1.2 mm (3/64")
Maximum	2 mm (5/64")

PINION APPLICATION

	Pinion Advance	Approximate Temperature Rise Above Shaft Temperature
15 teeth	1.65 mm ± 0.13 mm (.065" ± .005")	144° C (260° F)
14, 16 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 to 25 teeth	1.14 mm ± 0.13 mm (.045" ± .005")	99° C (178° F)
D87 motor pinions	2.16 mm ± 0.13 mm (.085" ± .005")	189° C (340° F)

GEAR CASE

Support arm wear limit	100.8 mm (3-31/32")
Lubricant	as specified in M.I. 1756
Initial charge of lubricant	
56 tooth gears	8 kg (18 lbs)
57 thru 60 tooth gears	7 kg (16 lbs)
61 and 62 tooth gears	6 kg (14 lbs)

SUPPORT BEARINGS

Lubricant	as specified in M.I. 1756
Lubricant level	
Wide window	
Minimum	64 mm (2-1/2")
Maximum	127 mm (5")
Narrow window	
Minimum	64 mm (2-1/2")
Maximum	Overflow
Wear limits	See Fig. 27

Replacement Support Bearings, Dual Seal, Narrow Window

203 mm (8") Axle	Felt-Lock Twin Seal Bearing Part Number	Rotating Seal Part Number	Superseded Twin Seal Bearing Part Number
Standard Bore	9557789	9323317	9526107
0.8 mm (1/32") Undersize Bore	9557790	9323317	9526108
1.6 mm (1/16") Undersize Bore	9557791	9323317	9526109
2.4 mm (3/32") Undersize Bore	9557792	9329249	9526110
3.2 mm (1/8") Undersize Bore	9557793	9329249	9526111
0.8 mm (1/32") Oversize Flange	9557794	9323317	9526112
1.6 mm (1/16") Oversize Flange	9557795	9323317	9526113

SUPPORT BEARING (CONT'D)

210 mm (8-1/4") Axle	Felt-Lock Twin Seal Bearing Part Number	Rotating Seal Part Number	Superseded Twin Seal Bearing Part Number
Standard Bore	9557797	9329250	9526099
0.8 mm (1/32") Undersize Bore	9557798	9329250	9526100
1.6 mm (1/16") Undersize Bore	9557799	9329250	9526101
2.4 mm (3/32") Undersize Bore	9557800	9329248	9526102
3.2 mm (1/8") Undersize Bore	9557801	9329248	9526103
0.8 mm (1/32") Oversize Flange	9557802	9329250	9526104
1.6 mm (1/16") Oversize Flange	9557803	9329250	9526105

SPECIAL TOOLS

	Part Number
Pyrometer, Hand Type	8364533
Heater, Induction Type Pinion	8041446
Die, Armature shaft, (Pinion Threads)	8050721
Die Holder	8050722
Protector, Pinion	8054871
Pliers, Thermo-Grip	8064918
Spacer	8116073
Handle, Sliding "T"	8127528
Wrench, Pinion Nut	8127529
Lifter, Brush Springs	8140869
Grinder, Alignment Bar	8210141
Vacuum Cleaner Blower	8210140
Dust Collector	8210142
File, Commutator Slot	8238905
Remover-Installer, Filler Cap	8250241
Gauge, Brush Slot	8259133
Knife, De-Burring	8270339
Aligning Tool, Brush Holder Spring Cell	8305181
Scale, Brush Holder Spring Tension	8415805
Adapter, Commutator Grinder (Frame Mounted)	8354226
Adapter, Commutator Grinder (Brush Holder Mounted)	8354239
Grinder, Commutator	8355891
Grinding Stones, Finish Grade – 2 reqd.	8201791
Grinding Stones, Medium Grade – 2 reqd.	8496921
Brush Seater Stone (Chalk Stone)	8204957
Aluminum Oxide Paper, 220 Grit – 216 mm x 46 m (8-1/2" x 50 yd.) roll, 3 m (10 ft) per motor	19AB12
Hydraulic Pinion Puller Kit	9533321
Hydraulic Pump	8302969
Coupling	9533327
Nipple, Adapter (1/2"-20)	9533328
Gland Nut (With Sleeve)	9533322
Tube, Connection	9533323
Tube, Connection	9533324
Tube, Connection	9533325
Elbow, Connection	9533326
Hydraulic Oil, 3.8 liters (1 U.S. Gal.)	8246430
Retaining Nut (Models D47B2 and D47B3 only)	8303020
Nipple, Adapter (Models D47B2 and D47B3 only), 3/8"-24	9566297
Manual Pinion Puller Kit (Models D37 and D47 only)	8303330

SPECIAL TOOLS (CONT'D)

Pulling Plate Assembly	8168577
Pulling Plate	8168604
Includes Studs:	
5/8"-11 NC (C.E. bearing cap)	8168606
3/8"-16 NC (P.E. outer oil ring)	8168611
5/8"-11 UNC-2A (P.E. bearing cap)	8204436
Wick Lubricator Cleaning Machine	9502464
Depth Gauge And Indicator, Pinion Advance	9539037

MATERIAL LIST

Enamel, Red Air Drying, 3.8 liter (1 U.S. Gal.)	8061131
Varnish, Black Air Drying	
3.8 liter (1 U.S. Gal.)	8122347
208 liter (55 U.S. Gal.)	8116521
Mineral Spirits	8492097
Flux, Solder, 0.5 kg (1 lb)	8122570
Solder, Tin Base, No. 8 Wire, Approx. 23 kg (50 lb) Spool	8225761
Compound, Caulking, 0.7 kg (1-1/2 lb) Can	8198204
Neoprene, Liquid 3.8 liter (1 U.S. Gal.)	8213281
Primer, Buff, 3.8 liter (1 U.S. Gal.)	8228726
Thread Lubricant, Texaco Threadtex No. 2303, 19 liter (5 U.S. Gal.)	8307731
Cleaner, Liquid (pinion application), 19 liter (5 U.S. Gal.)	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.

RTV, Silicone Compound 340 g (12 oz.) Cartridge	8366747
Compound, Silicone, 140 gram (5 oz.) Tube	8453256
Pin, Brush Holder, Stud-To-Frame	455731
Shim, Axle Cap, 0.46 mm (.018")	8102851
Spindle Hole Plug, Brush Holder	8166383
Cable, Grounding	8351902
Tubing, Heat Shrinkable, 38 mm dia. x 76 mm lg (1-1/2" x 3")	8352037
Setscrew, Pinion End Of Shaft	9418862
Lubricating Oil, All Purpose, 208 liter (55 U.S. Gal.) Drum	8211926
Armature Bearing Lubricant	
Sealed Grease Application	
Shell Cyprina RA Grade 3	
16 kg (35 lb) Pail	8249819
52 kg (114 lb) Drum	8249820
Gear Lube Additive, Lubrizol Anglamol 99, 208 liter (55 U.S. Gal.) Drum	9528518

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
D77B 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
D77E 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
D87 Models				
Cover	0.425	15	0.170	6
Cap	0.567	20	0.198	7
Roller Cage O.D.	0.085	3	0.028	1
Roller Cage I.D.	0.085	3	0.028	1
	1.162	41	0.424	15
D87X , D87Y, D77X3A, D87A				
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