MAINTENANCE INSTRUCTION

TRACTION MOTOR OVERHAUL

Traction motor overhaul instructions are presented in seven sections, each under separate cover, and contain detailed instructions to completely disassemble, inspect, overhaul, assemble, and test the traction motor. Refer to Maintenance Instruction M.I. 3904 for general or "running" maintenance of the traction motor and also for procedures to remove the traction motor from the locomotive truck. These instructions apply to Models D19, D29, D29CC, D29CC-7, D29CCBT, D31, and D36 traction motors unless specifically identified. References to Model D29 motors will include Models D29CC, D29CC-7, D29CCBT, and D31.

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

SECTION 5
ARMATURE INSPECTION AND RECONDITIONING

INTRODUCTION

This section provides procedures for mechanical and electrical inspection and reconditioning of traction motor armatures.

ARMATURE CLEANING

Prior to making any inspections, the armature should be thoroughly cleaned to remove all dirt, oil, and grease. The armature may be cleaned by blowing off all loose dirt and carbon dust, from the inside and outside of the armature using high volume, low pressure, dry air. In cases where air or dry wiping cloths can not remove caked dirt or grease, a brush or soft wood or fibre scrapers may be used. In severe cases it may be necessary to dampen a cloth in solvent which has a fast evaporation rate, such as Stoddards Solvent to loosen and remove imbeded deposits.

CAUTION: Ensure there is adequate ventilation and safety precautions are observed when handling inflammable fluids such as Stoddards Solvent which has a flash point of 46° C (115° F).

Clean ventilation holes in armature core. Minimum diameter of holes is 23.8 mm (15/16").

If a solvent has been used to clean the armature, blow off as much of the solvent as possible using high volume, low pressure, dry air. Let the armature stand until remaining solvent has evaporated and the armature is completely dry before making any electrical tests. Mechanical inspection may be performed during the period when armature is drying.

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

INSULATION RESISTANCE TEST

Before any work is performed on the armature, the armature should be given an insulation resistance test using a 500 volt DC megohmmeter. The armature shall have a minimum insulation resistance of 3 megohms.

If the armature fails to meet the minimum resistance reading, place the armature in an oven for 6 hours at 110° C (230° F). Recheck armature insulation resistance after armature has cooled to room temperature. If the readings are still low, the armature must be checked to determine the cause.

Perform the following sequence. Megger between each step.

1. Remove string band from commutator end.
2. Remove pinion end bands.
3. Remove pinion end end-bell.
4. Remove commutator end band.

If megger reading is still below tolerance, the armature must be rewound. Refer to Section 6, Armature Overhaul.

When megger readings are to the specified limits, perform a high frequency or surge test on the armature winding insulation.

HIGH FREQUENCY OR SURGE TEST

NOTE: The purpose of this is to stress the insulation of the armature in a manner similar to actual operation of the motor. The insulation between turns, the insulation between layers of windings, and the insulation between the windings and the core should be simultaneously subjected to voltage (potential) stress.

A high frequency test can be performed which induces voltage to the armature coils electromagnetically. Because the armature winding is the equivalent of an inductance coil, this can be accomplished by impressing a high frequency voltage on the armature coils. Refer to Service Data for file number of a high frequency tester. Test the armature at 1800 volts. If a variation between high and low reading occurs that is greater than 10%, the armature is not acceptable. The minimum acceptable reading is 50 volts.

A surge test can be performed comparing voltage waveforms using a suitable surge tester.

If armature fails on high frequency or surge test and the failure is located in an upper coil, the upper coil can be raised and repaired, providing condition of the armature warrants this type of repair.

If armature passes the high frequency or surge test, perform a commutator bar-to-bar resistance test.

COMMUTATOR BAR-TO-BAR RESISTANCE TEST

The commutator bar-to-bar resistance test is made with a low resistance ohmmeter which measures resistance in micro-ohms. Refer to Service Data for ohmmeter part number.

The ohmmeter may be set for reading the scale direct or in multiples of from 10 to 10,000. With the ohmmeter range switch set at X 10, the resistance indication between adjacent commutator bars should be 70-72 micro-ohms at an ambient temperature of 21° C (70° F), but variations in temperature and test equipment can result in indications as low as 60-62 micro-ohms. However, all bar-to-bar resistance indications on individual armature should be the same. Maximum allowable limits should be plus or minus 1 point on the scale from the established normal indication. Normal indications of the armature are established by taking resistance readings on approximately 15 bars. The indication most consistent can be considered the normal reading.

Very high resistance or open circuits in the armature will cause the overload protector in the ohmmeter to open. Press RESET button to put ohmmeter back into operation.

The commutator riser should not be disturbed before performing the bar-to-bar resistance test. Removing paint with a file or a light lathe cut may temporarily correct any high resistance problem by copper drag-over between the coil leads and the riser. If this should occur, the ohmmeter would not show a high resistance indication. In such case, the real trouble, for example a poor solder connection, would show up in operation.

Perform bar-to-bar resistance test as follows:

1. Turn on ohmmeter and allow at least 20 second warmup.

NOTE: Ensure undercut slots between commutator bars are clean and free of any copper chips before performing test.

2. Set ohmmeter range switch to X 10. Ensure ohmmeter is in a level position.

3. Each test prod of the ohmmeter has two needle points: red is the potential needle and black is the current needle. The prods must be placed so that the red needles are towards the center of the commutator, Fig. 1.

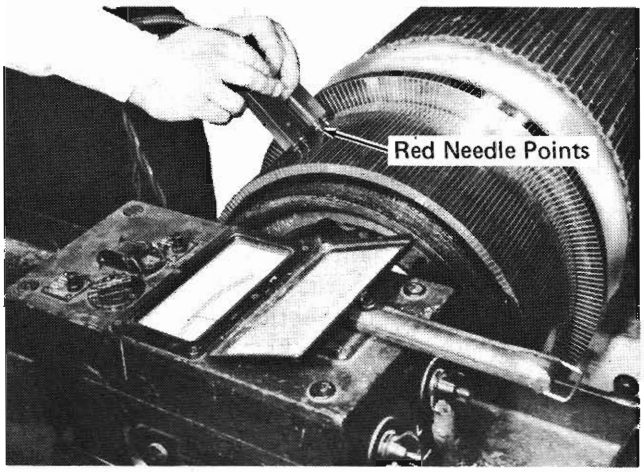

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Fig. 1 - Bar-To-Bar Resistance Test

4. Apply prods on adjacent commutator bars with enough pressure to penetrate surface of the copper. When moving to the next bar, move one prod at a time to adjacent bar, breaking contact with the black needle then the red needle.

5. Establish a "normal" indication by checking approximately 15 bars.

6. Check every bar in the commutator, allowing one point above and below as a maximum over the established normal indication. Mark the commutator bar edge to indicate any high or low indication for later correction.

   Indications above normal indicate high resistance due to defective circuits, usually caused by poor solder joints in the commutator riser.

NOTE: When making a bar-to-bar check of the commutator, it is possible to determine if the problem is in the equalizer circuit (commutator bar cross connectors connect bars 180° apart, bar 1 is connected to bar 106, etc.) or main winding circuit. Example of main winding problem: bar-to-bar indications on the first 90° of the commutator are 64-66 micro-ohms (range switch set to X 10), which may be considered the normal indications. Continuing indications of 73-75 micro-ohms are found. This variation is greater than the plus or minus 1 point on the ohmmeter scale and indicates a high resistance connection. Because of the equalizer circuit, either identical, higher, or slightly lower indications will be found 180° from the previous high indications. In this case, the 180° indications are 69-70 micro-ohms. To correct, repair the leads where the high indications occurred. When these leads are repaired, the 180° indications will also be corrected.

This example would indicate that the problem was in the main winding circuit and not in the equalizer circuit because the indications were not the same 180° apart, however, the equalizer circuit provides a parallel path between windings 180° apart and will reflect the high indication on the opposite side of the commutator.

Example of equalizer circuit problem: normal indications around commutator are 64-66 micro-ohms and high indications are experienced 180° apart. It can be assumed the problem is in the equalizer circuit. Higher than normal indications 180° apart indicates problem in the equalizer circuit.

It is not possible to determine which side of the equalizer circuit has the problem. Repair the leads on one side of the equalizer circuit and if problem remains, repair the other side.

If after reworking both sides of the equalizer circuit, problem still exists, the equalizer circuit is either oxidized to the point where solder will not adhere, or the equalizer is out of the circuit. To verify this condition, place one test prod on a commutator bar with high indications, bar 1; place the other test prod on bar 106. With the range switch set to X 100, the normal indication should be approximately 13 micro-ohms. If the ohmmeter indicates 20 micro-ohms, or higher, the equalizer is definitely out of the circuit, and the armature must be rewound. It is possible to have a motor operating with improper contact on equalizer leads, but it is not recommended, as a failure may result with considerable damage to the commutator.

7. When correcting suspected connections, hand solder with pure tin solder. If a large number of leads show high readings, the complete commutator riser should be resoldered. If after soldering, a bar-to-bar resistance check still shows high indications, the riser should be split at the lead connection and the leads fluxed and set. Solder the riser again, if test results are still unsatisfactory, the armature should be stripped and rewound. Unsatisfactory indications after the second soldering usually indicates cracked armature coil straps. Refer to Section 6, Armature Overhaul, for rewinding procedure.

MAGNETIC PARTICLE INSPECTION

A magnetic particle inspection should be performed to qualify the shaft for reuse before dimensional checks are made. Ensure the shaft is clean and free of all rust and oil.

The shaft must be magnetized to perform a magnetic particle inspection, but the shaft may retain enough residual magnetism to check. Check the shaft for residual magnetism by one of the following two methods:

1. Apply magnetic powder to the end of shaft. The powder should adhere. If it does not adhere, it will be necessary to magnetize the shaft.

2. Suspend a short length of iron or steel wire at the end of a piece of string near the end of the shaft. Observe any attraction of the wire to the shaft. If no attraction is observed, it will be necessary to magnetize the shaft.

NOTE: If there is any doubt as to the shaft being sufficiently magnetized, the shaft should be magnetized.

The shaft can be magnetized by using a unit capable of producing 500 to 700 amperes of alternating current and wrapping three turns of No. 0000 flexible cable around the ends of the shaft.

Apply current to the cable turns to magnetize the shaft.

After it is determined that shaft is magnetized, apply magnetic powder sparingly to the tapered pinion seat and adjacent machined surfaces, refer to Fig. 2. Any circumferential cracks or defects are causes for rejection. These cracks usually occur at the pinion end especially on the tapered area.

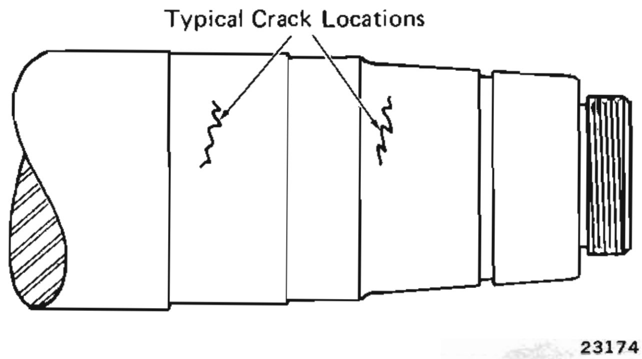


Fig. 2 - Circumferential Shaft Defects

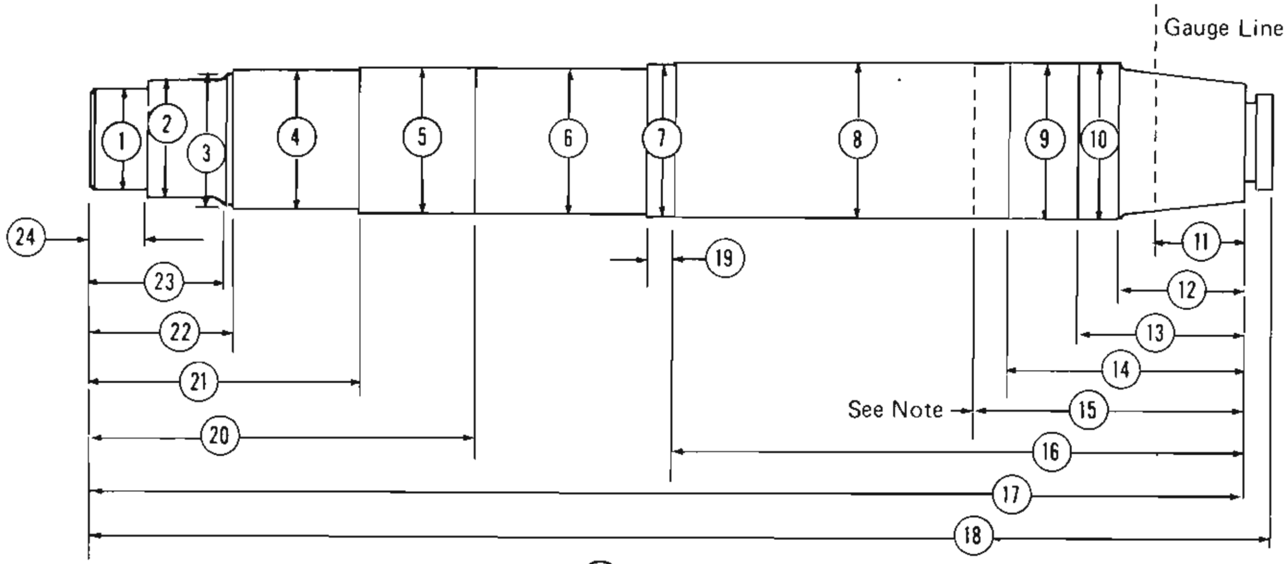
NOTE: Service history has indicated that small longitudinal cracks have little effect on service life of the shaft, therefore this Maintenance Instruction does not include inspection for cracks in that direction. Any longitudinal marks on the shaft that have raised edges should have the raised edges blended in with the shaft to allow proper fit of parts that will be assembled to the shaft.

DIMENSIONAL INSPECTION

1. Inspect the shaft diameters for size as shown in Fig. 3. Inspect bearing and pinion seat surface for damage, fretting, corrosion, or roughness. These surfaces may be cleaned up by light rubbing with crocus cloth. Do not rub or polish axially or work below the normal surface. If surfaces are heavily damaged or beyond tolerances of Fig. 3, the shaft should be replaced.

NOTE: When armature shaft bearing diameters are worn beyond acceptable limits, the diameters may be built up by plating. Plated shafts should be identified with a 5 mm (3/16") letter P stamped adjacent to the armature serial number.

2. Inspect the threads of the bolt holes on the commutator end of the shaft, Fig. 4. If threads are nicked or slightly damaged, retap holes. The threads must be class 1B. If threads are severly damaged or beyond thread pitch diameter limits, replace shaft with a new shaft.



NOTE: The 110.548 mm (4.3523") diameter (8) must be held to this location.

Diameter	mm	(inches)	Diameter	mm	(inches)
1.	75.029 +0.000 -0.013	2.9539 +0.0000 -0.0005	14.	173.0	6-13/16
2.	88.964 +0.000 -0.013	3.5025 +0.0000 -0.0005	15.	227.0	8-15/16
3.	101.55 +0.00 -0.03	3.998 +0.000 -0.001	16. (D36)	357.2	14-1/16
4.	101.702 +0.000 -0.013	4.0040 +0.0000 -0.0005	16.	412.8	16-1/4
5.	106.197 +0.000 -0.013	4.1810 +0.0000 -0.0005	17. (D36)	750.09 ± 0.13	29.531 ± 0.005
6.	106.223 +0.000 -0.013	4.1820 +0.0000 -0.0005	17.	835.02 ± 0.13	32.875 ± 0.005
7.	110.49 +0.00 -0.03	4.350 +0.000 -0.001	18. (D36)	769.14 ± 0.18	30.281 ± 0.007
8.	110.548 +0.000 -0.013	4.3523 +0.0000 -0.0005	18.	854.08 ± 0.18	33.625 ± 0.007
9.	110.043 +0.000 -0.018	4.3324 +0.0000 -0.0007	19.	19	3/4
10.	109.487 +0.000 -0.013	4.3105 +0.0000 -0.0005	20.	279	11
11.	70	2-3/4	21.	195.3	7-11/16
12.	90.5	3-9/16	22.	100.0	3-15/16
13. (D36)	99.2	3-29/32	23.	96.8	3-13/16
13.	123.8	4-7/8	24.	42.06 ± 0.13	1.656 ± 0.005
14. (D36)	148.4	5-27/32			

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Fig. 3 – Armature Shaft Dimensions

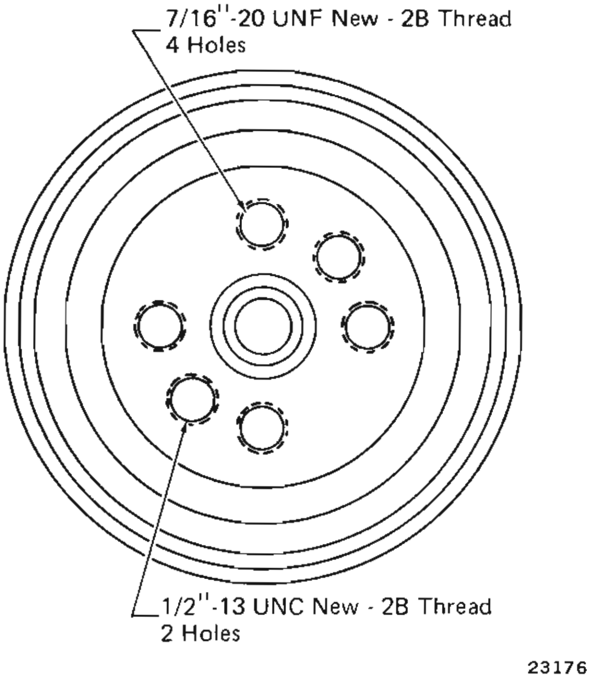

Fig. 4 – Commutator End Shaft Bolt Holes

3. Inspect the threads on the pinion end of the shaft, Fig. 5. If the threads are nicked or slightly damaged, rework threads with armature shaft die. Refer to Service Data for die and die holder part number. Check thread pitch diameter. Acceptable thread pitch diameter is 67.513 mm to 67.915 mm (2.6580" to 2.6738"). If threads are severely damaged or beyond thread pitch diameter limits, replace shaft with a new shaft.

MECHANICAL INSPECTION

1. Inspect pinion end inner grease seal, Fig. 5, for wear. Grease seal outer diameter should be a minimum of 181.74 mm and a maximum of 181.86 mm (7.155" and 7.160"). If seal is beyond tolerance replace seal with a new seal.

NOTE: Any armature with wire slot wedges must have wire slot wedges removed and replaced with phenolic wedges.

2. Inspect the armature coil slot wedges, Fig. 5. Slot wedges must not be loose or charred. Check slot wedges for loose condition by placing fingers on a wedge and tapping each wedge with a small hammer. Charred or loose wedges must be replaced. If there is only slight evidence of loose slot wedges, the armature should be vacuum impregnated with varnish. Refer to Varnish Treatment portion of this section.

If it is determined that slot wedges must be replaced, refer to Armature Overhaul, Section 6, for procedure.

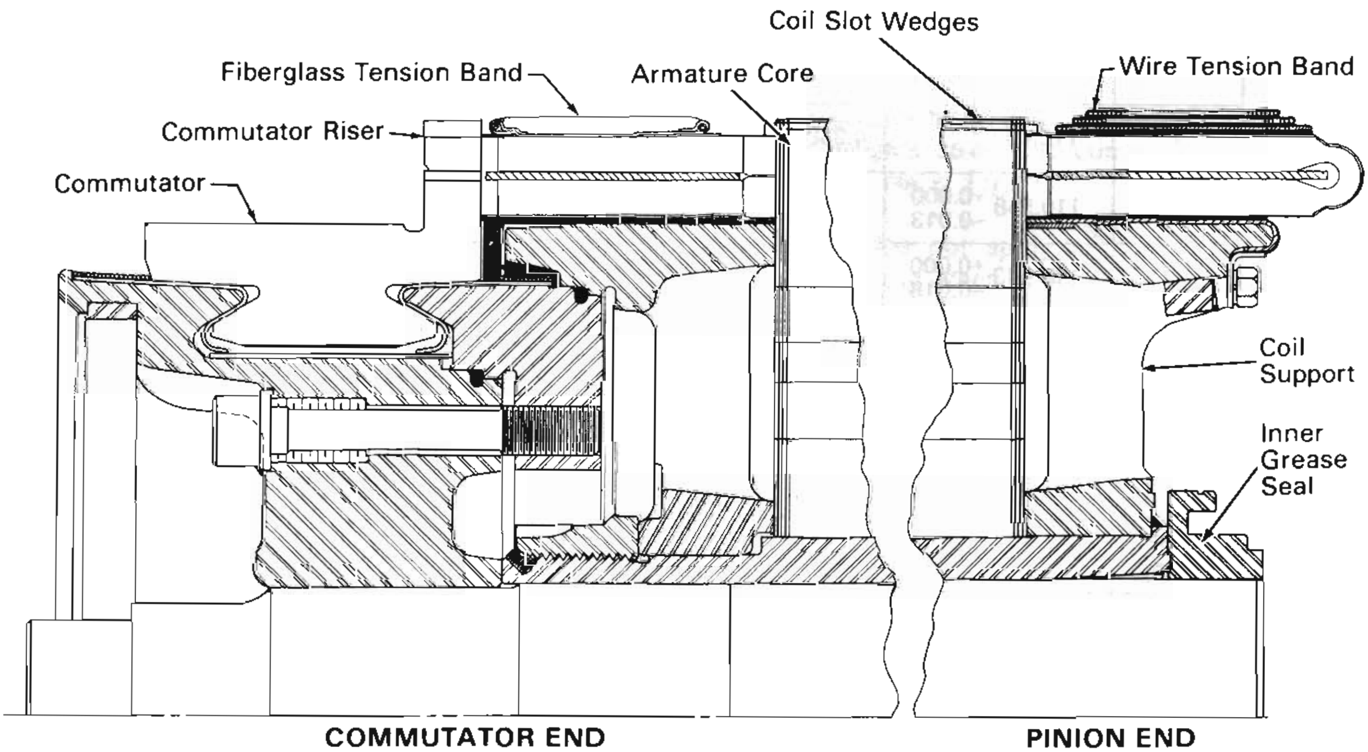

Fig. 5 - Tension Band Assembly

3. Inspect pinion end coil support for cracks. When cracks are found, coil support must be replaced with a new coil support.

4. Inspect armature insulation for evidence of powdering. If very slight evidence of powdering is found, it will be generally accompanied by loose coil slot wedges or wire bands. This can be reworked by rebanding, rewedging, and varnish impregnating the armature. Refer to Overhaul, Section 6 for procedure.

   If evidence of heavy powdering is found, the armature must be rewound. Refer to Armature Overhaul, Section 6, for procedure.

5. Inspect armature winding for dry or charred insulation. If insulation is charred, the armature should be rewound. If insulation is dry, the armature should be varnish impregnated.

6. Check armature core. If core is rubbed or scuffed on outer diameter, the damage is acceptable over any portion of the core outer diameter providing the damaged area, after cleanup (lamination edges must be clearly visible), has not been reduced more than 46 mm (.018").

TENSION BANDS

Inspect the wire or fiberglass tension bands to ensure bands are not loose or damaged. If the bands are cut, scuffed, cracked, or wire bands have thrown solder or are loose, and the rest of the armature is satisfactory, the bands should be replaced. Refer to Section 6 of this Maintenance Instruction for replacement procedure.

Current model traction motor armatures are banded with non-magnetic wire at the pinion end and banded with fiberglass tape at the commutator end, Fig. 5. Those units manufactured with wire bands at both the commutator end and pinion end should have the commutator end band replaced with fiberglass band when the band requires replacement. Refer to Section 6 of this Maintenance Instruction for replacement procedure.

On a unit with a satisfactory wire band on the commutator end, the wire band must have a covering of fiberglass tape and epoxy. Apply fiberglass tape and epoxy as follows:

1. Remove all paint and dirt from the commutator end wire band with a wire brush.

2. Lightly brush the insulation protruding from under the wire band on both sides.

3. Ensure the area to be coated is free of dirt and paint. Epoxy must have a clean bonding area.

4. Wipe wire band with petroleum solvent.

5. Apply one turn of 25 mm (1") masking tape to top of commutator riser.

6. Mix epoxy resin kit per instructions furnished with kit. Refer to Service Data for kit part number.

7. Apply a coat of epoxy resin with a 51 mm (2") brush from the rear edge of the commutator riser to the edge of the insulation under the band at the core side of the band. Coat the surface of the wire band as evenly as possible.

NOTE: The application of epoxy resin should require about one half of the mixed resin.

8. Apply one layer of ten mil glass tape, one half lapped to the entire surface as follows:

   a. Begin taping next to the commutator riser. Hold end of tape in place with epoxy resin.

   b. Wrap the half lapped layers across the entire area end so that the last turn is even with the edge of the insulation on the core side of the band.

   c. Apply tape as tightly as possible. Rotate armature as tape is applied.

9. Apply remainder of epoxy resin to the taped surface. Cover surface thoroughly, working resin into tape. To smooth out resin, rotate armature while holding brush against the coated area.

10. The armature must be rotated during time required to cure the epoxy resin. This rotation is required to prevent uneven surfaces from forming. The resin will cure at room temperature in 2-1/2 to 4 hours; however this time can be accelerated by applying heat to the resin. The heat can be applied with infrared lamps or by placing the armature into an oven for 20 minutes with an oven temperature between 135° C to 150° C (275° F to 302° F). Regardless of the curing method used, the armature must be rotated during the curing period.

When it is required to replace the wire or fiberglass tension bands, refer to Section 6 of this Maintenance Instruction.

When armature coils are chafed either lightly or to the extent that the copper coil straps are exposed in the area under the tension band, and the armature otherwise checks satisfactorily, chafed coils may be repaired as follows:

1. Lightly sand over the chafed area with fine sandpaper to remove any dirt or carbon from chafed edges of the insulation and to remove any oxidation or varnish from the exposed strap.

2. Clean area to be repaired with a clean cloth moistened with alcohol. Do not over saturate the area.

3. When alcohol has evaporated, apply silicone compound to chafed areas of insulation or exposed copper straps. Spread silicone compound evenly with a putty knife or similar tool over chafed area. Spread silicone compound as evenly as possible to maintain a depth of 2 mm (1/16") over chafed area. Taper silicone compound off to surrounding areas. Spread silicone compound so there is a continous layer between adjacent chafed coils. Do not attempt to cover individual coils in areas where adjacent coils are chafed.

4. After application of silicone compound, the armature must remain at room temperature for 24 hours to cure the silicone compound before proceeding with subsequent operations. Heating and varnish treatment will destroy the silicone compound if silicone compound is not allowed to cure properly.

5. Prepare the armature for vacuum impregnation. Cover the diamond area with one butted layer of fiberglass tape for protection during varnish treatment.

6. Vacuum impregnate armature with varnish. Refer to Varnish Treatment portion of this section.

7. After varnish treatment is completed and armature has cooled to room temperature, remove the layer of fiberglass tape and check for possible damage to silicone compound.

INSULATION INSPECTION

Inspect armature insulation for evidence of powdering. If very slight evidence of powdering is found, it will generally be accompanied by loose wedges or tension bands. This can be reworked by rebanding, rewedging, and varnish impregnating the armature. Refer to Slot Wedge, Tension Bands, and Varnish Treatment portions of this section for reworking armature.

If evidence of heavy powdering is found, the armature must be rewound. Refer to Armature Overhaul, Section 6, of this Maintenance Instruction.

Inspect for charred or dry insulation. If insulation is charred, the armature should be rewound. If insulation is dry, the armature should be varnish impregnated.

If the armature core is scuffed or rubbed on the outside diameter, the damage is acceptable over any portion of the core outside diameter providing the damaged area, after cleanup (lamination edges must be clearly visible), has not been reduced more than 0.46 mm (.018").

SLOT WEDGE INSPECTION

NOTE: Any armature with wire slot wedges must have the wire wedges removed and replaced with phenolic wedges.

Inspect armature slot wedges. Slot wedges must not be loose or charred. Check slot wedges for loose condition by placing fingers on a wedge and tapping the wedge lightly with a small mallet. Check each wedge in this manner. Charred or loose wedges must be replaced.

If there is only slight evidence of loose slot wedges, the armature, should be vacuum impregnated with varnish. Refer to Varnish Treatment portion of this section.

If it is determined that slot wedges must be replaced, refer to Armature Overhaul, Section 6, for procedure.

COMMUTATOR INSPECTION

Inspect the commutator on the armature assembly as follows:

1. Inspect commutator surfaces for standstill burns, damaged bars, high bars, raised mica, grooving, and powdered or loose mica segments. If the commutator brush surfaces and/ or riser have been damaged, they should be machined in a lathe before making further checks.

2. Check the diameter of the commutator brush surface. Condemning limit is 375 mm (14-3/4"). If below this limit, the commutator must be replaced.

   Maximum taper of this surface shall not exceed 0.3 mm (.010"); providing the surface has not recently been machined or stoned, in that case, the maximum taper, should not exceed 0.13 mm (.005"). The allowable out-of-round should not exceed 0.03 mm (.001"), total indicator reading, when shaft is rotated between centers. Assembled as a motor, the runout should not exceed 0.05 mm (.002") on this surface.

3. Check commutator for surface irregularities. The overall minimum and maximum indications of the dial indicator obtained in Step 2 are not applicable as a measurement of commutator surface irregularity. Commutator surface irregularity is concerned with bar-to-bar movement. An example of this would be to have readings around the commutator that have a total variation of 0.05 mm (.002"), however hidden within the 0.05 mm variation are six low areas, each spanning one or more bars. This commutator would cause the brushes to bounce with resultant damage.

   A commutator having a total variation of 0.10 mm (.004") with the minimum and maximum readings 180° apart is an acceptable commutator whereas the first example, 0.05 mm (.002") variation with several low areas, is not acceptable even though the total variation is much less.

   It is difficult to give a number value which would determine when a commutator should be ground. The values obtained by dial indicator must be evaluated with respect to performance of the generator (brush problems, flashovers, etc.) and a certain amount of personal judgment must be used. A useful "rule of thumb" is that any condition worse than 0.05 mm (.002") in a six bar span requires grinding the commutator.

4. Check the width of the riser (neck), which must be wide enough to provide sufficient stock so that after final commutator machining, the width shall not be less than 14 mm (9/16"). If less than 14 mm (9/16"), the commutator must be replaced.

5. Check the riser diameter. The minimum riser diameter is 457 mm (18").

NOTE: The area behind the riser can not be checked on armatures that have epoxy resin applied to the commutator end wire band.

6. Inspect for damaged tape band. If band is broken or burned through so that the V-ring is damaged, the commutator insulation V-ring must be replaced.

7. Inspect commutator spider for cracks. If cracks are found, the spider must be replaced with a new spider. Refer to Armature Overhaul, Section 6, for procedure.

8. If commutator meets specifications and no machining is required on brush surface, clean out slots between commutator bars across brush surface. Remove all carbon dust, dirt, and foreign matter from the slots. Special care must be taken to cut below any oil soaked or burned mica patches. This can be accomplished with a hack saw blade or similar tool. Care must be exercised not to scratch the brush surface of the commutator bars, or raise burrs on bar edges.

VARNISH TREATMENT

Armatures which have been repaired and inspected other than final machining of the commutator and armature balancing, should be vacuum impregnated with varnish. Varnish should be thinned to maintain Ford cup No. 4 orifice viscosity at 250-325 seconds at 21.1° C (70° F) and a minimum specific gravity of 0.900. Refer to Service Data for varnish and thinner information.

Perform vacuum impregnation of armature assembly as follows:

1. Clean armature core section thoroughly with petroleum solvent and wipe dry with clean dry cloths. On armatures with hydraulic pinion removal feature, remove 1/2"-20 set screw in the shaft center prior to varnish impregnation.

2. Brush-coat armature core tooth and wedge area with baking varnish. Do not thin varnish.

3. Preheat armature in a convection oven so that the average armature core temperature stabilizes at 120° C +5°, -10° C (248° F +9°, -18° F). Ensure core temperature does not exceed 125° C (257° F) or oven temperature does not exceed 175° C (347° F).

4. Remove armature from oven and place in vacuum impregnation tank. Average core temperature of armature should be between 100° C to 120° C (212°-248° F) when placed in tank. Do not allow armature core to cool below 100° C before placing in tank.

5. Apply 710-760 mm (28-30") vacuum to tank for 15 minutes. Bolt down tank lid while vacuum is building up.

6. With vacuum still on tank, run varnish into tank to minimum level of 8 mm (5/16") over rear side of the commutator riser outside diameter to a maximum of up to, but not over, the riser face. If varnish should flow over riser face, wipe riser face clean with petroleum solvent. Break down foam by occasionally injecting small amounts of CO_2 into impregnating tank as varnish rises around armature. If vacuum is not sufficient to draw varnish up to the required level, CO_2 may be injected into the tank to force the varnish up to the desired level. Do not open release valve to admit atmospheric air into impregnating tank.

7. Reduce vacuum to zero with CO_2 additions. Check that varnish is at the proper level, then increase CO_2 pressure to 200-275 kPa (30-40 psi). Allow armature to remain under pressure for a minimum of 15 minutes to a maximum of 20 minutes.

8. Reduce CO_2 pressure to 70-100 kPa (10-15 psi) by opening vacuum valve. Do not open release valve to atmospheric air. Empty varnish from impregnating tank using the 70-100 kPa CO_2 pressure.

9. Open release valve to atmospheric air. Allow armature to drain for 25 minutes. Upon completion of drain period, close release valve and apply 710-760 mm (28-30") vacuum for a minimum of 5 minutes.

10. Remove armature from impregnation tank and wash varnish from shaft, end bell, and commutator face and risers with a rag saturated with petroleum solvent. On armatures with hydraulic pinion removal feature, thoroughly clean hydraulic hole passages with solvent, then re-apply 1/2"-20 set screw finger tight.

11. Place armature in a convection oven.

NOTE: Bake cycle should start within 15 minutes after completion of impregnation cycle.

12. Attach thermocouple to armature commutator. Bake armature 6 hours after average core temperature reaches 155° C (311° F). Ensure commutator temperature does not exceed 155° C or oven temperature does not exceed 175° C (347° F).

13. Remove armature from oven and while armature is still between 40°-60° C (104°-140° F), perform a ground test at 3200 volts for 1 minute. If armature fails ground test, armature will have to be rewound. Refer to Section 6, Armature Overhaul for rewinding procedure.

14. If commutator bolts have been loosened for any reason during repair, torque commutator bolts to 136 N·m (100 ft-lbs). Tack weld commutator bolts after torquing.

FINAL ARMATURE CHECKOUT AND MACHINING

1. When the armature has cooled to room temperature, place armature in a lathe and check runout of the shaft.

   Maximum runout of pinion end bearing seat is not to exceed 0.064 mm (.0025").

   Maximum runout of pinion end inner grease seal face is not to exceed 0.05 mm (.002").

   Maximum runout of commutator end bearing seat is not to exceed 0.038 mm (.0015").

2. Check and machine, if required, the commutator brush surface and commutator riser to obtain a good surface. Refer to Service Data for commutator limits.

COMMUTATOR UNDERCUTTING

1. Check the depth of the slots between the commutator bars. Slots should be between 1-2 mm (3/64"-5/64") deep. If slot depth is not within tolerance, commutator mica will have to be undercut.
2. Check width of mica between bars. Early models have 0.84 mm (.033") mica and current models have 1.27 mm (.050") mica, Fig. 6.
3. Undercut commutator mica using undercutting tool similar to Fig. 7, if required. After undercutting, blow off any loose copper and mica using low pressure, high volume, dry air. Do not blow copper dust toward armature windings.

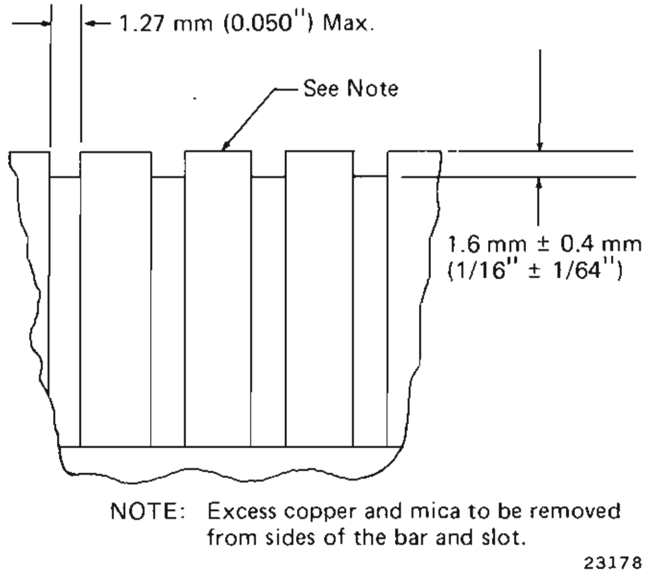

Fig. 6 - Commutator Bar Mica Limits

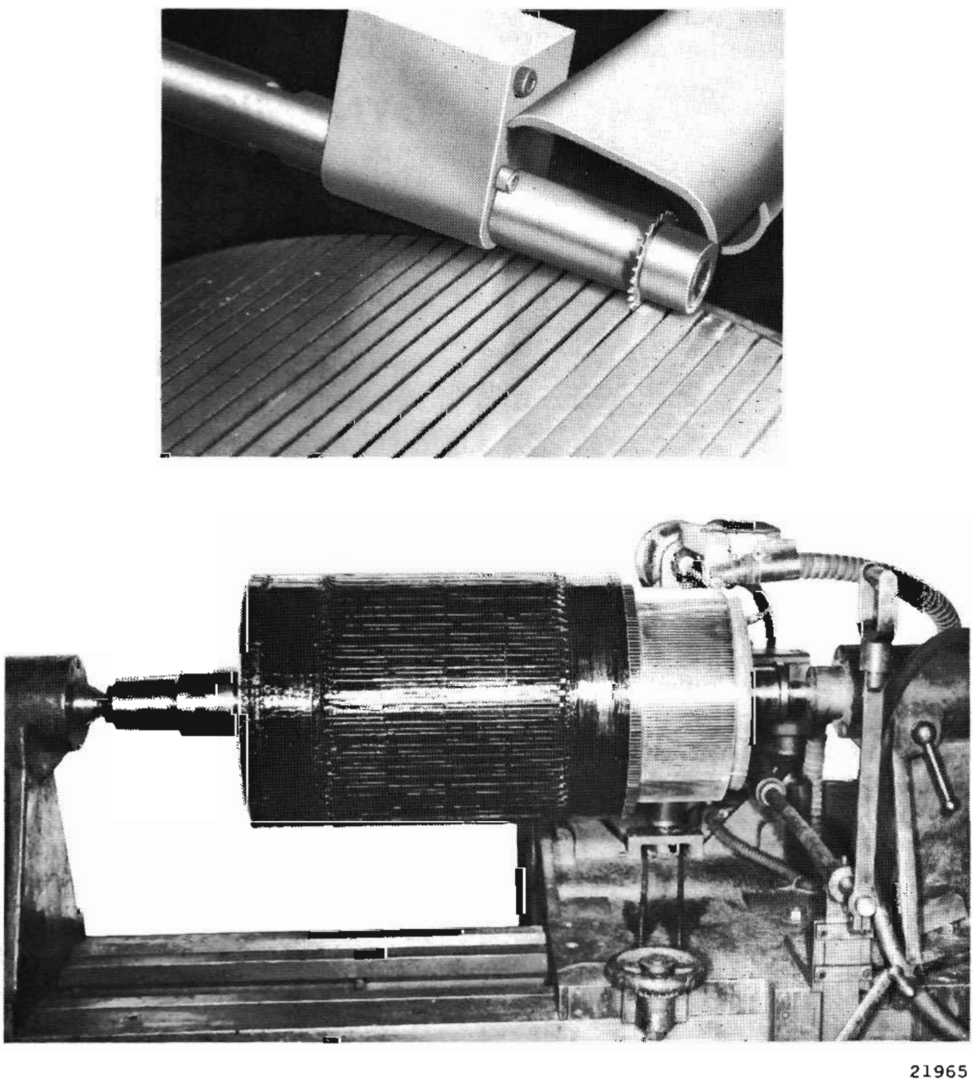

Fig. 7 - Apparatus For Undercutting Mica

DE-BURRING COMMUTATOR

1. Place armature in a lathe and grind and polish the commutator as required using a fine grit stone. Refer to Service Data for stone part number. Ensure grinding operation does not exceed the commutator diameter limits. Refer to Service Data for commutator limits.

2. Check commutator taper. Taper shall not exceed 0.13 mm (.005") maximum.

3. Break the edges of commutator bars using a de-burring tool as shown in Fig. 8. Refer to Service Data for commutator bar de-burring tool.

   Hold tool at an angle of approximately 45° and pull tool in manner shown in Fig. 8.

   Be careful as tool is pulled out of the slot so as not to damage the insulation over the "V" ring.

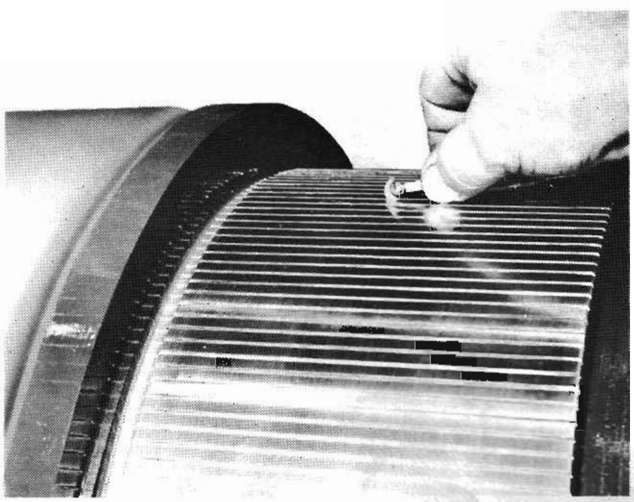

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Fig. 8 - Removing Burrs From Commutator Bars

4. After commutator bars have been properly de-burred, hand polish the surface of the commutator using 0/6 220 grit sandpaper, moving sandpaper around the surface. Do not polish back and forth between the riser and the "V" ring.

   Blow off commutator using low pressure, high volume, dry air. Do not blow copper dust towards the armature windings.

5. Remove any remaining dirt, varnish, and red air drying enamel on the mica segments between commutator bars, on the riser face, and in the recess until mica is clean. Hand tools such as scrapers and hacksaw blades may be used. Remove any copper bridging over mica segments on riser face. Minimum space between bars to be 0.8 mm (1/32") in TIG welded area. Brush out any copper dust or particles that may accumulate.

NOTE: The 3 mm (1/8") deep relief at the base of the commutator riser is acceptable at 1.6 mm (1/16").

6. Perform a final bar-to-bar resistance test. Refer to Commutator Bar-To-Bar Resistance Test portion of this section.

DYNAMIC BALANCE

The armature should be dynamically balanced at 500 RPM to within 1440 mg·m (2 in.-oz.). Armature must also be checked when "floated" through "critical speed." Refer to Service Data for balance weights and set screw part numbers.

On the pinion end of the armature, apply balance weights to the coil support and weld in place, Fig. 9.

On the commutator end of the armature, apply balance weights under the commutator "V" ring, and weld in place. Fig. 9.

CAUTION: Do not apply excessive heat to "V" ring when welding balance weights, as heat may damage string band or distort steel "V" ring.

ARMATURE PAINTING

Paint the pinion end coil support and end bell, and commutator spider with red air drying enamel. Do not paint over core section or bands.

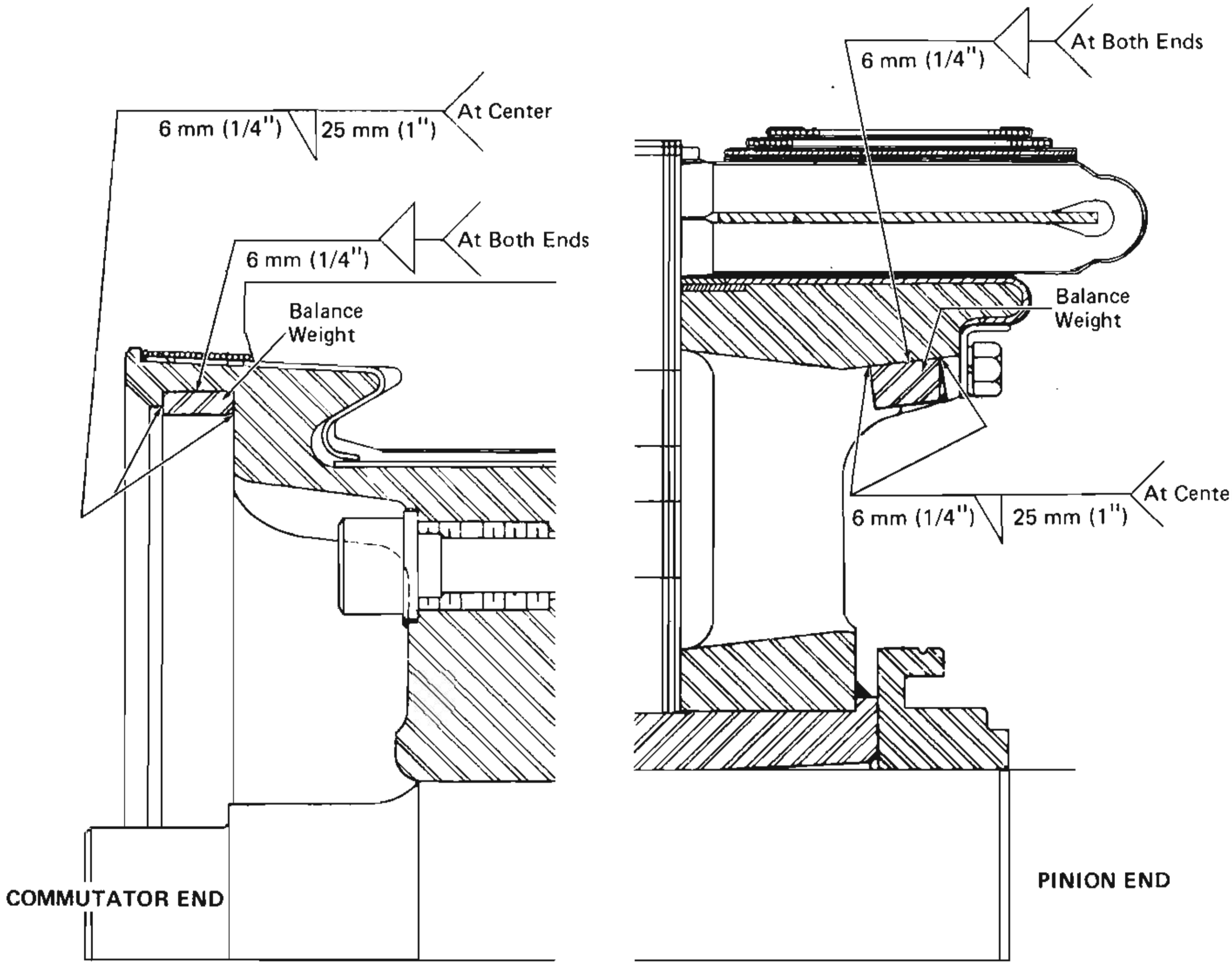

Fig. 9 – Balance Weight Placement

SERVICE DATA

EQUIPMENT LIST

	Part No.
Armature Shaft Die, (Pinion Threads)	8050721
Die Holder	8050722
Ohmmeter, Low Resistance (Ductor) 0-100 Ohms	8068118
Leads, Box-To-Hand spikes	8107968
Laminated Spacer (shim), Pinion End	8135277
Spacer (shim), Commutator End	8082782
Grinding Stone, Commutator	8204167
Balance Weight, Pinion End	8175825
Balance Weight, Commutator End	8175824
De-Burring Tool, Commutator	8270339
High Frequency Tester	*File No. 890

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

MATERIAL LIST

	Part No.
RTV, Silicone Compound, 170 g (6 oz) Cartridge	8345495
Epoxy Primer	8430367
Adhesive Film, 0.25 mm x 16 mm x 33 m (.010" x 5/8" x 36 yd) Roll	8455335
Enamel, Red Air Drying	
1 litre (1 qt)	8061130
19 litre (5 gal)	8048876
Epoxy Resin Kit	8260298
Tape, Glass, 10 Mil	8136648
Tape, Glass Band, 0.33 mm x 19 mm (.013" x 3/4")	8279297

**Varnish, Electrical Insulating - Modified Polyester Y-432 (Sterling Varnish Co.)

Thinner Solvent For Above Varnish

*Chevron No. 1300 Solvent

*Thompson - Hayward Chemical Company No. 2026 Solvent

**Xylol Thinner

An alternate thinner solvent may be blended using the following materials:

*Mineral Spirits (Rule 66 Type Thinner) 80%

*Butyl Acetate - Technical Grade 20%

NOTE: The above blend is required because the varnish sets up in the tank when mineral spirits thinner is used alone. Butyl acetate prevents this.

*To be used where compliance with pollution control regulations is required.

**Xylol may be used as a substitute thinner, however, Xylol DOES NOT comply with pollution control regulations.

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

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