ELECTRO-MOTIVE

M.I. 3952-4
*Rev. B

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 4
STATOR INSPECTION AND RECONDITIONING - Electrical

INTRODUCTION

During traction motor overhaul, the stator should be cleaned and inspected to determine mechanical and electrical quality to ensure satisfactory performance during subsequent operation. Visual and electrical inspections are required to determine what type of repair, if any, is needed.

The inspections should be carefully made and all rework performed according to the outlined procedures.

STATOR CLEANING

Clean the inside and outside of the stator assembly by blowing out dirt, dust, and other contaminants using high volume, low pressure, clean, dry, compressed air. Avoid excessive air pressure which could cause insulation damage.

EXTENSIVE CLEANING

If the stator is extremely dirty or oily, the inside and outside may be cleaned with a steam cleaner such as Dober Chemical Corporation Cleaner 6006 or Turco Chemical Company Steamfas.

Use an 85g per 3.79 litre (3 oz/gal) mixture of cleaner and water and maintain a tank temperature of approximately 60° C to 71° C (140° F to 160° F).

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

Steam clean the stator assembly as follows.

NOTE: The solution tank should be approximately 0.9 m x 1.2 m x 0.9 m (3' x 4' x 3'). Two steam guns are required such as Hurriclean Steam Guns, Model 551.

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

1. Regulate a No. 1 steam gun to obtain a good soapy solution.

2. Steam clean stator holding No. 1 steam gun nozzle at an angle to the stator about 100 mm to 150 mm (4" to 6") away.

3. Rinse the stator thoroughly using a No. 2 steam gun with a combination of clean water and steam to remove all traces of cleaner.

4. Blow off stator using high volume, low pressure, clean, dry, compressed air.

LIGHT CLEANING

If stator does not require a steam cleaning, wipe the frame and insulation with a clean cloth dampened with a suitable solvent such as Stoddards Solvent.

WARNING: Provide adequate ventilation when using solvents. The usual precautions should be observed when handling inflammable liquids such as Stoddards Solvent, which has flash point of 46° C (115° F).

DRYING STATOR

After stator is properly cleaned, dry the stator by placing in a 145° C (293° F) oven for 8 hours. Remove the stator from the oven and allow to cool to ambient temperature.

MEGGER AND HIGH POTENTIAL TEST

MEGGER TEST

Check field coils and brush holder cables with a megger. Each circuit should check 4 megohms minimum. If the readings are less than 4 megohms, the stator may require more drying time. Repeat drying cycle. If after the second drying cycle the megger readings are still below 4 megohms, isolate each coil to determine which coil is defective. Replace any coil found to be defective.

HIGH POTENTIAL TEST APPARATUS

It is very important that a reliable high potential tester be used, to ensure that an adequate test is obtained and also that unnecessary over-stressing of the insulation does not take place. The following features should be incorporated into the high potential tester.

Wave Form

Voltages specified in high potential testing are root-mean-square (RMS) voltages, and the wave form should be such as to have a limit of 5% third harmonic. This limitation fixes the peak voltage for any RMS voltage. Wave form may be influenced by the capacity of the testing apparatus used relative to the size of the equipment being tested. A serious peak on the voltage wave may result if the test apparatus used is too small for the equipment being tested.

Surges

Pay special attention to the method of changing voltages on the primary when high potential testing to prevent very harmful surges.

Regulation

Specifications for regulation are that the secondary voltage drop should not exceed 20% under actual test conditions.

HIGH POTENTIAL TEST PROCEDURE

WARNING: Use extreme care when making high potential test. Ensure all personnel are at a safe distance from the equipment before applying the voltage.

Dangerous over-voltage surges may occur when making or breaking the high voltage circuit with the electrodes.

Perform the high potential test as follows:

1. Place electrodes firmly to the equipment being tested.

2. Ensure control knob is set at zero and turn on control switch.

3. Press ON pushbutton firmly and hold while rotating control knob slowly to the specified voltage. Hold ON pushbutton for time specified, then rotate control knob back to zero. Release ON pushbutton.

4. Turn off control switch and discharge equipment.

HIGH POTENTIAL TEST

Before any repairs to the stator, apply a 4200 volt high potential test to stator for 1 minute at room temperature.

VISUAL INSPECTION

EXTERNAL LEADS AND CONNECTORS

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

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

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

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

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

FIELD COILS, INTERPOLE COILS, AND INTERIOR CABLING

1. Inspect all interior cables for deterioration, fraying, and wear.

2. Inspect insulation on main field coils and interpole coils for deterioration, and overheating. Overheating will be noticed at the midsection of the sides of the interpole coil where the coil is closest to the main field coils.

3. Inspect coils for looseness. Looseness will usually be indicated by rust around the washers. All loose coils must be removed and insulation checked visually.

4. Inspect interpole coil insulation. Special attention should be given to the pinion end of the interpole coil for spongy or loose insulation. If spongy or loose insulation is discovered, the coils should be replaced.

5. On Models D19, D29, and D36, check air baffles. If one or more baffles have moved out from under the main field coils, all coils should be removed and checked for loose insulation.

6. On Model D31, air baffles are welded to frame. Ensure baffles are properly welded.

7. Check pinion end and commutator end frame side of the main field coils for loose or bulging insulation. If one or more coils are found to have loose insulation, all main field coils should be replaced.

8. Check interpole coils on the long sides of the coils. If no evidence of loose insulation is found and the coils are otherwise satisfactory, the coils can be reused. If loose insulation is found, the coils should be replaced.

NOTE: If it is determined that stator requires recabling, refer to applicable portions of Stator Overhaul instructions.

EXTERNAL LEADS AND CONNECTOR REPAIRS

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. 1.

   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. 1.

   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

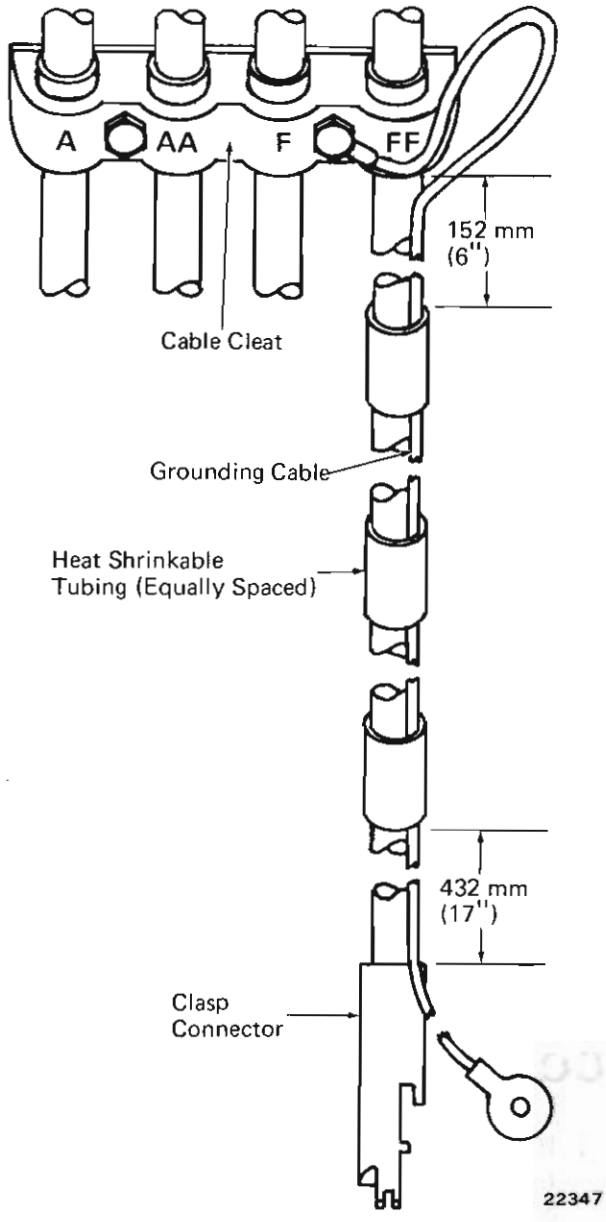

Fig. 1 – External Lead Grounding Cable Application

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 Step 1d for heat-shrinkable tubing application procedure. Refer to Service Data for RTV compound part number.

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

SOLDERING CONNECTORS TO CABLE LEADS

NOTE: Refer to Service Data for material part numbers.

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

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

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

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

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

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

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

RESISTANCE AND POLARITY CHECK

RESISTANCE CHECK

1. Install brush holders if removed. Ensure contact areas between brush holders and terminals are clean and tight. Position brush holders in the holding blocks as far back as possible to allow all the clearance possible between the holders and the commutator when assembling the armature into the stator.

2. Measure the resistance of the main field and interpole coil circuits with a Kelvin bridge and a thermometer as follows. Refer to Fig. 2.

   a. Place thermometer in the stator along side one of the coils.

   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.

   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. Remove thermometer and record temperature.

The resistance values of the circuits when readings are converted to 75° C (167° F) should be as follows:

		Ohms (± 2%)
D19	Main Field	0.0271
	Interpole Field	0.0173
D29	Main Field	0.0271
	Interpole Field	0.0171
D31	Main Field	0.0260
	Interpole Field	0.0171
D36	Main Field	0.0239
	Interpole Field	0.0155

If the readings are high, 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. Replace any defective coils with new coils. Refer to Coil Replacement section of this Maintenance Instruction.

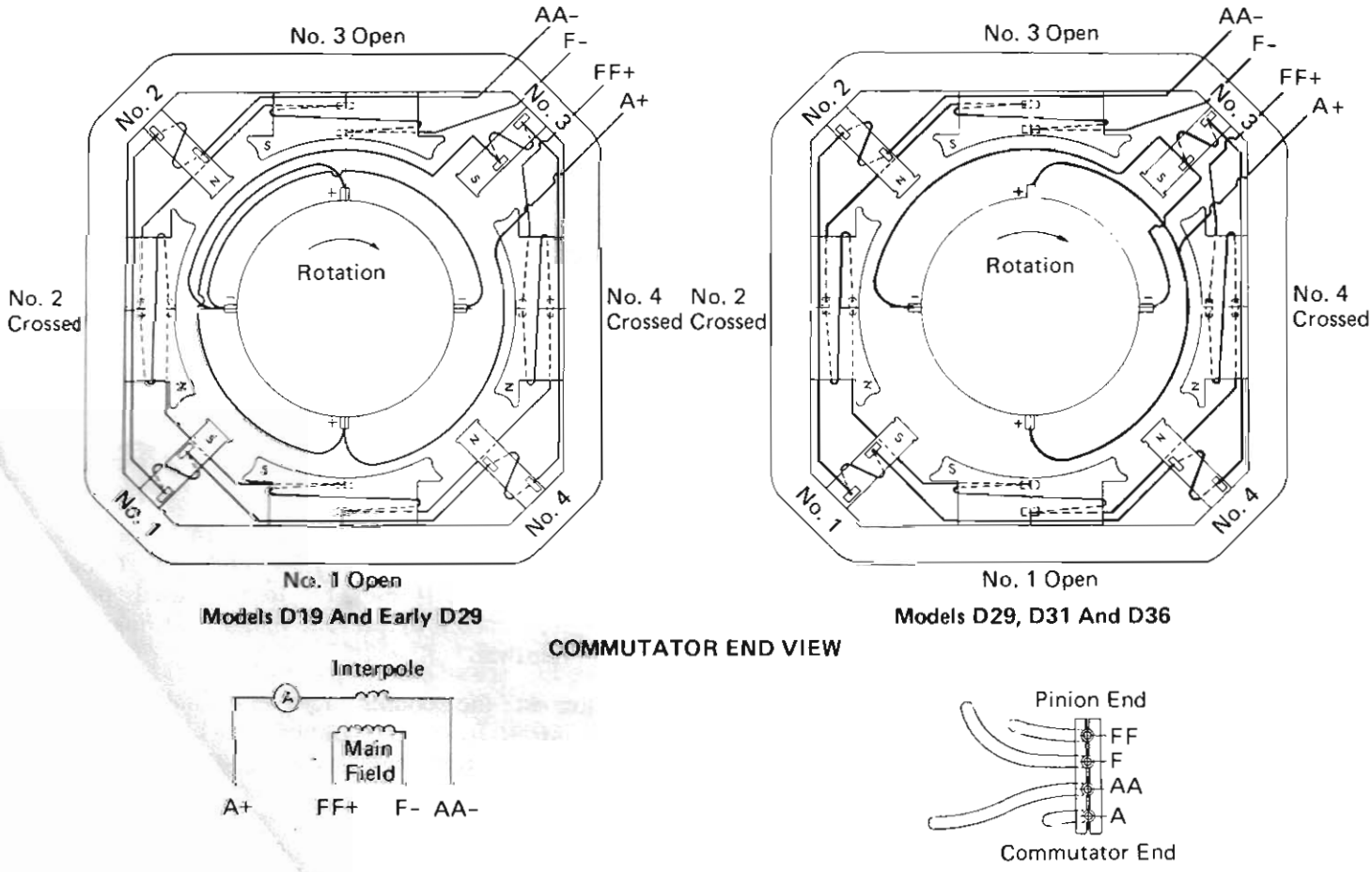

Fig. 2 - Wiring Diagram

POLARITY CHECK

If the resistance is satisfactory, polarity must 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. 2.

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

NOTE: Main field coil polarity reference will apply as shown when "FF" lead is of positive potential.

Interpole coil polarity reference will apply as shown when "A" lead is of positive potential.

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.

When satisfactory resistance and polarity checks have been obtained, paint the inside of the stator with red air drying enamel. Protect the housing bores, faces, and brush holder terminals from paint.

STATOR OVERHAUL

COIL REMOVAL

When it is necessary to remove the stator coils, it is advisable to place the stator in a fixture, similar to Fig. 3, that can be rotated to position the coils for removal. Lifting fixtures to handle the coils are also recommended. Refer to Service Data for fixture part numbers.

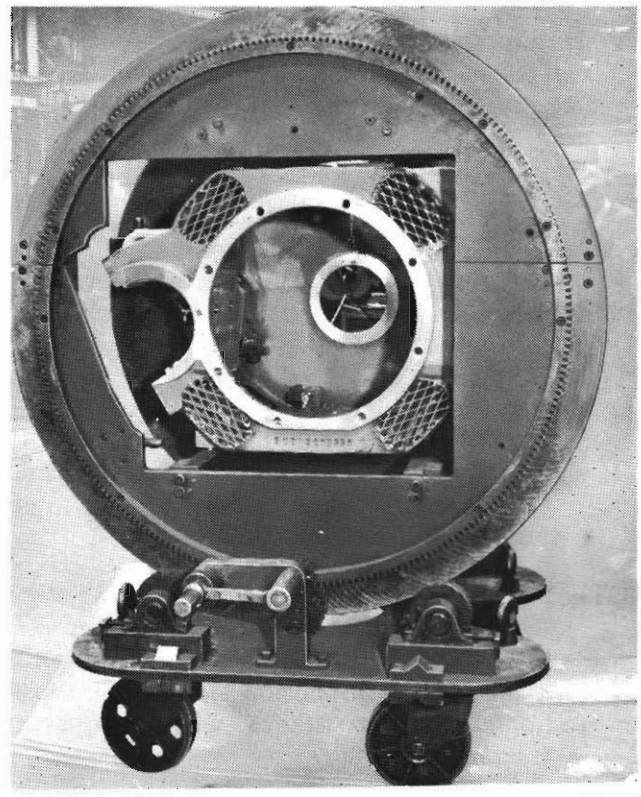

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Fig. 3 - Stator Holding Fixture

Heating equipment will also be required to loosen the brazed connections between the coils. Brazing equipment may be used for this operation. Refer to Service Data for brazing equipment part number.

Before the main field coils can be removed, it is necessary to break the tack weld holding the No. 4 main field coil bolts. Remove tack weld carefully to prevent damage to the stator frame. All weld must be removed to allow clearance for the socket to remove the bolts.

Remove the field coils as follows:

1. Position and lock the stator in a holding fixture.

NOTE: If the external leads are not to be reused, they should be cut flush with the rubber grommets. If they are to be reused, position cables to prevent damage during coil removal.

2. Start at the commutator end and remove insulation from the connections between the coils to be removed. Cut all ties holding leads and connectors.

3. Using brazing equipment, disconnect interpole connections. Position stator as necessary to disconnect all interpole connections.

CAUTION: Use brazing equipment carefully to prevent burning or damaging the connectors between the interpole coils, as they may be satisfactory for reuse. Apply heat gradually until connection is loose.

4. When connectors between the interpoles are removed, position the stator so an interpole is located at the top.

5. Using lifting fixture and a hoist, position the fixture under and up against the interpole coil to be removed as shown in Fig. 4. Refer to Service Data for fixture part number. Remove the bolts holding the coil to the stator frame.

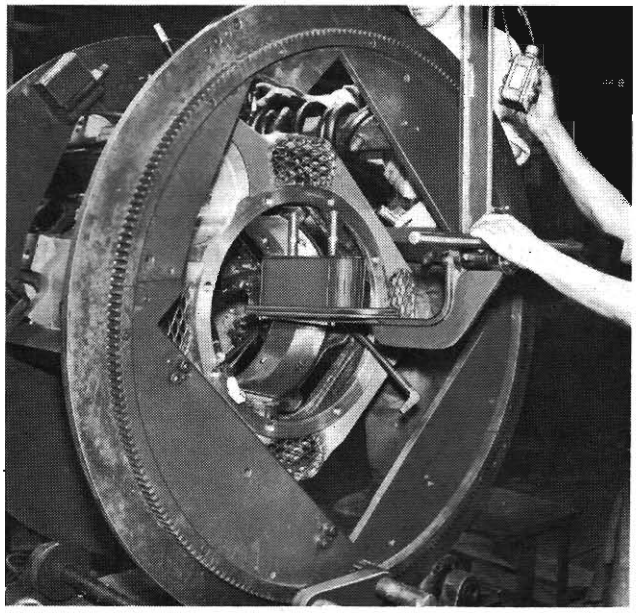

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Fig. 4 - Interpole Coil Removal

6. Lower the lifting fixture and coil to a point where the coil can be removed from the stator frame. Remove coil and set aside.

7. Position the stator for the next interpole coil to be removed and repeat operation until all defective coils are removed.

NOTE: Save any shims that were between the frame and the interpole coil. These shims are reused to ensure coil tightness. Ensure shims remain with the coil they were with.

8. When required, perform similar operations to remove the main field coils. Use lifting fixture for main field coils. Refer to Service Data for fixture part number.

Main field pole pieces can be removed from the field coils and reused provided they are not damaged. The interpole coil and pole piece should be replaced as an assembly.

If all the coils are removed from the stator, clean the frame inside and out to remove all grease and dirt. Check the rubber grommets that protect the outside leads from the frame. If damaged, the grommets should be removed and replaced with new grommets.

When the frame is cleaned, check inside of frame for burrs or burnt spots that might interfere with coil replacement. The air gap between the main pole and interpole coil pads should also be checked. The distance between the interpole pads when measured at the center of the pads (at equal distance from each end) should be from 761.87 mm to 762.25 mm (29.995" to 30.010"). The main pole pads dimension should be from 610.97 mm to 613.00 mm (24.054" to 24.234") when measured in the same manner. These dimensions should be maintained to obtain the proper air gap when the coils are assembled into the frame.

After the stator frame has been cleaned and checked, paint the inside with red air drying enamel. Protect the pole and coil pad areas, the housing bores and faces, and the portion of brush holder block that holds the insulated studs of the brush holders from paint.

COIL REPLACEMENT

Model D19 traction motor coils cannot be mixed with later model coils due to differences in coil design and resistance.

When it is necessary to replace only one or a few coils in either type stator, make the replacement with the same type coil removed. When it is necessary to replace all the coils in either a D19 or D29 stator, make the replacement with D29 coils to obtain the advantage of the improved coil used in the D29 motor. Model D31 or D36 coils must be replaced with the same type as those removed.

No machining or rework is necessary on the Model D19 frame to prepare the frame for installing D29 coils. When a D19 frame is assembled with current model coils, it is advisable to change the model designation on the nameplate of the unit to the current model.

When replacing coils ensure the proper type lead grommets are used to protect the stator leads and proper rubber spacer blocks are used for interpole connector supports.

All stators being rebuilt are to have axle cap or axle cap simulator installed at the pinion end prior to assembly of the coils to the frame. The axle cap or simulator should remain in position during assembly until armature has been assembled into the stator. Refer to Service Data for axle cap simulator part number.

All coil studs are to be lubricated with Texaco Threadtex. Refer to Service Data for Threadtex part number.

INSTALLING MAIN FIELD COILS

The coil locations have been numbered as to position in the stator frame. Refer to Fig. 5. When facing the pinion end, the No. 1 main field coil is located at the bottom of the frame and counting counterclockwise, the other three main field coil positions are No. 2 opposite axle, No. 3 top, and No. 4 axle side.

When installing the coils in the stator frame, the No. 4 coil is installed and positioned using a line-up gauge. The No. 4 coil then becomes the reference point when spacing other coils.

Install the main field coils as follows. Refer to Fig. 5.

1. If the rubber grommets were removed from the four lead holes, install new grommets. Ensure the proper grommets are used for the type of frame being used. Keep the large edge of the grommet to the outside of the frame.

2. On Models D19, D29, and D36, install air baffles as follows:

NOTE: Model D31 has air baffles welded to frame.

   a. Position the frame so that an interpole pad is located at the bottom. Using air baffle positioning fixture, place the locating knobs on the bottom of the fixture into the interpole bolt holes and tighten

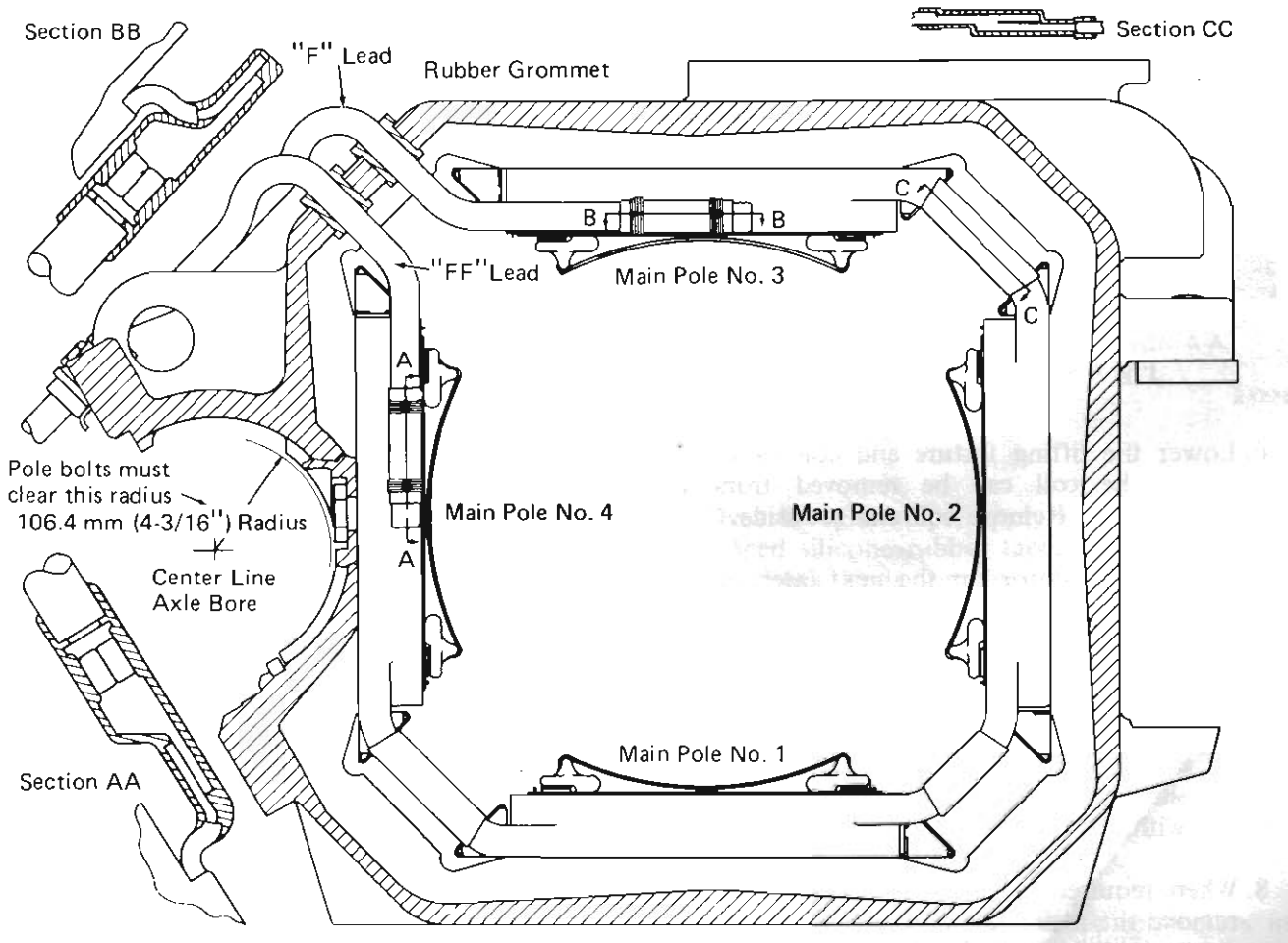

Fig. 5 - Main Field Coil Locations From Pinion End

the two top hand-screws. Position the fixture in the frame so the end locking-screw handle is facing the commutator end.

b. Place one air baffle on either side of positioning fixture into the location provided, Fig. 6. Ensure the baffle is flat on the coil pad of the frame. Tighten lock-screw handle on end of fixture to lock baffle in place. Check tightness of the two top hand-screws to ensure positioning fixture is held securely in frame.

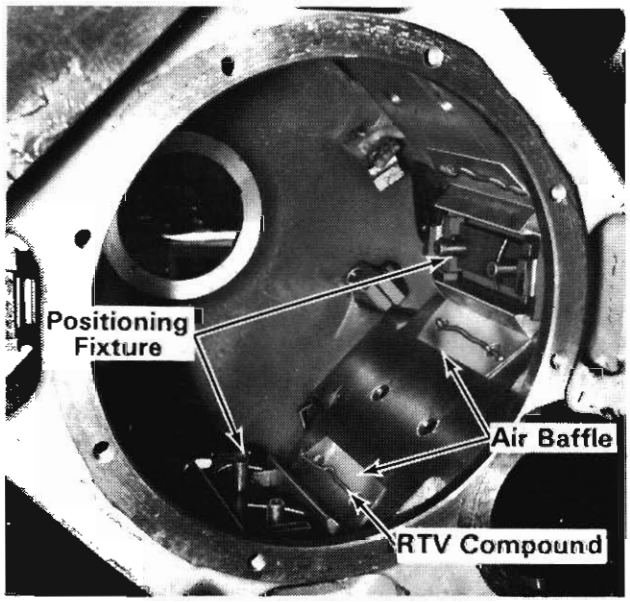

Fig. 6 – Model D19, D29, And D36
Air Baffle Positioning Fixture

c. Repeat Step 3 at the other three interpole locations installing two baffles and one positioning fixture at each location.

d. Apply a bead of RTV compound, 6 mm (1/4") in diameter and 229 mm (9") long on the coil side of the air baffle, Fig. 6. The RTV should be centered across the two 25 mm (1") diameter baffle holes. Refer to Service Data for **RTV** part number.

NOTE: The pressure of the coil against the baffle will spread the RTV evenly. Remove any excess RTV that may extrude into the space between the air baffle and the side of the main field coil.

3. Before placing the main field coils into the frame, it is necessary to assemble the coils on the pole pieces. When assembling the coils to the poles, the No. 4 main coil is assembled on the pole without studs. The other three coils are assembled to poles having studs. To assemble coils to pole, proceed as follows:

a. Place new main field coil on a suitable work bench.

b. Place steel washer on coil.

c. Place coil and washer assembly on a qualified pole piece, being careful not to damage the insulation on the coil. Coil must be assembled on the washer and pole piece so that when the assembly is placed in the frame, the leads will be turned toward center of the bore as shown in Fig. 7.

NOTE: It is necessary to assemble and braze the external leads to the No. 3 and No. 4 coils before installing these coils in the stator frame. Space limitations make it difficult to braze these connections when the coils are in the frame.

4. Braze the external leads to the No. 3 and No. 4 main field coils as follows:

a. Apply flux to the 38 mm (1-1/2") flat surface of the terminal lug of the "F" lead and the top lead of the No. 3 coil. Refer to Fig. 5, Section B-B.

b. Position leads to ensure maximum surface contact and insert a piece of silver brazing solder between lead and lug.

c. Position brazing equipment over surface to be brazed and clamp the joint together.

d. Actuate transformer to braze the joint together, being sure the joint gets hot enough so silver solder will flow to obtain a good joint. Add silver brazing alloy to the edges as required as filler.

e. When braze is completed, wait until solder has solidified and remove brazing equipment. Brush joint clean and file off any burrs or sharp projections being careful to protect coil insulation from the filings.

f. Repeat brazing operations for the No. 4 coil, securing the "FF" lead to the coil. Refer to Fig. 5, Section A-A.

5. Insulate the connections with one layer of silicone rubber tape half lapped. Start taping

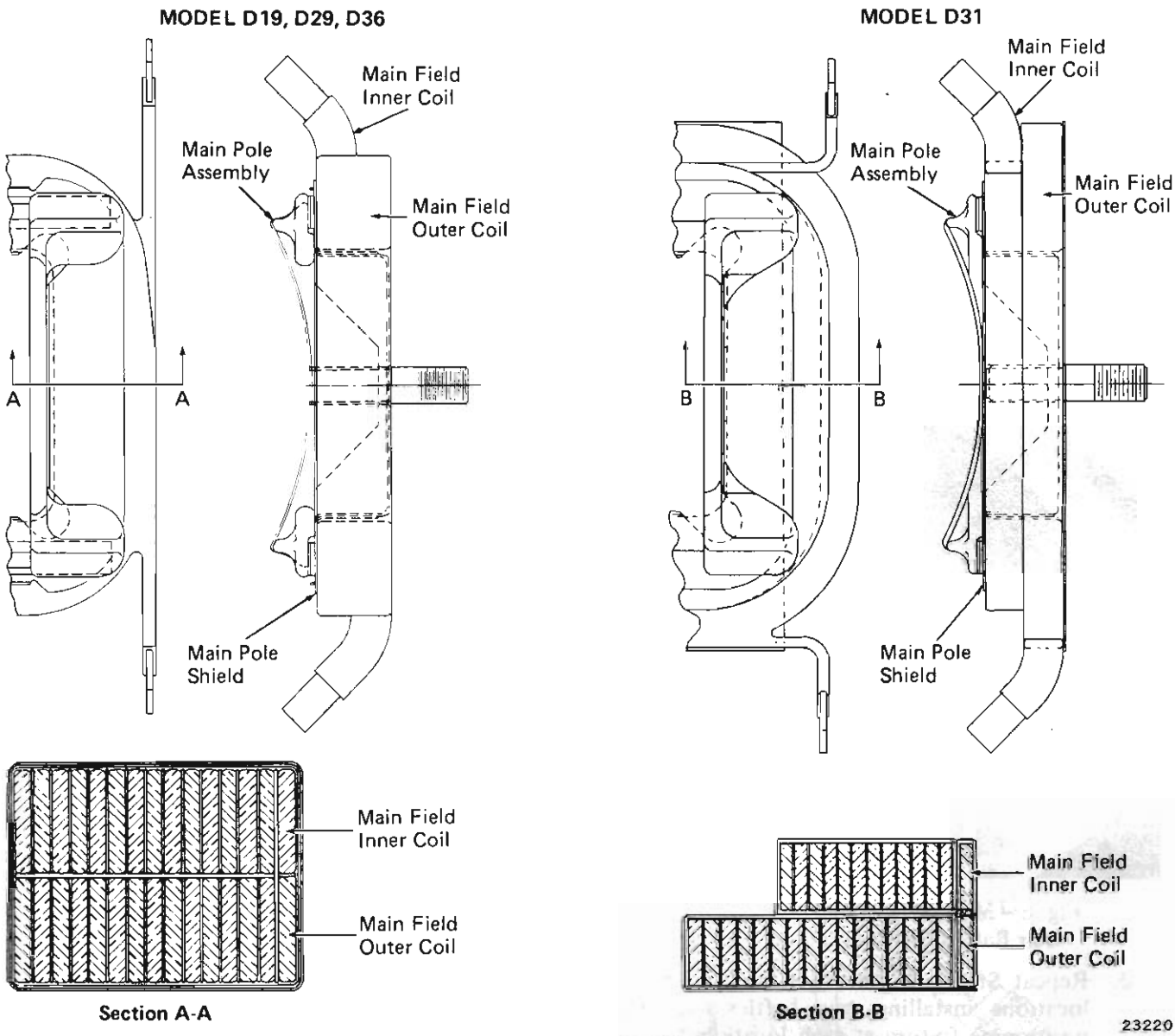

Fig. 7 - Main Field Coil Position On Pole And Shield

one tape width before the joint, tape over joint, and finish one tape width beyond joint. Tape overall with one layer half lapped of glass adhesive tape. Start and finish glass tape one half the tape width beyond the silicone rubber tape.

NOTE: The silicone rubber tape must be kept in plastic containers until ready for application. This is a self-vulcanizing tape and must be kept free of dirt and not handled excessively before or during application. Connector and cable surfaces to which tape is to be applied must be clean.

6. Index stator frame fixture so that location for No. 1 main field coil is at top position. Using lifting fixture, position No. 1 coil assembly on fixture and move into stator frame with coil leads facing the pinion end, Fig. 8. Align studs of coil assembly with holes in stator frame and raise coil assembly. Apply nuts and lockwasher to pole studs and tighten nuts. Remove lifting fixture.

7. Index stator frame fixture so that location for No. 2 main field coil is at the top position. Repeat Step 6 for assembly of No. 2 main field coil.

8. The No. 3 and No. 4 main field coils are assembled in a similar manner except the leads previously brazed to the coil will have to be inserted and pulled through the rubber grommet as the coil is placed in the frame. Use caution when pulling the cable lead through the grommet to prevent lead from twisting or knotting.

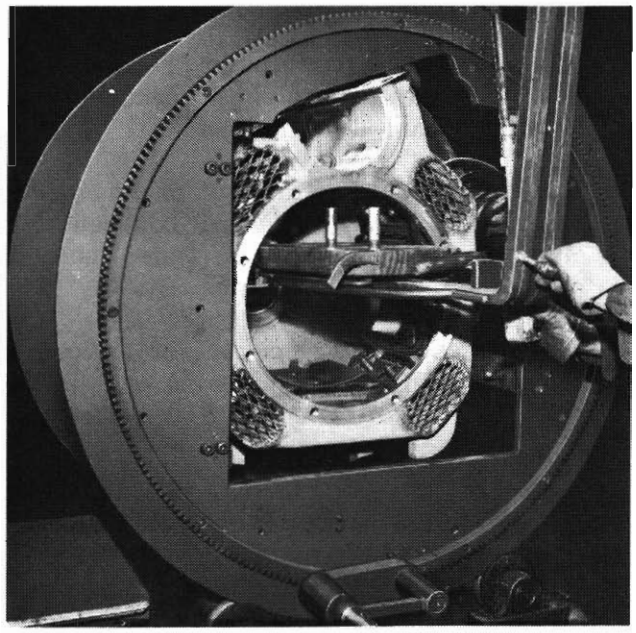

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Fig. 8 – Main Field Coil Being Placed Into Frame

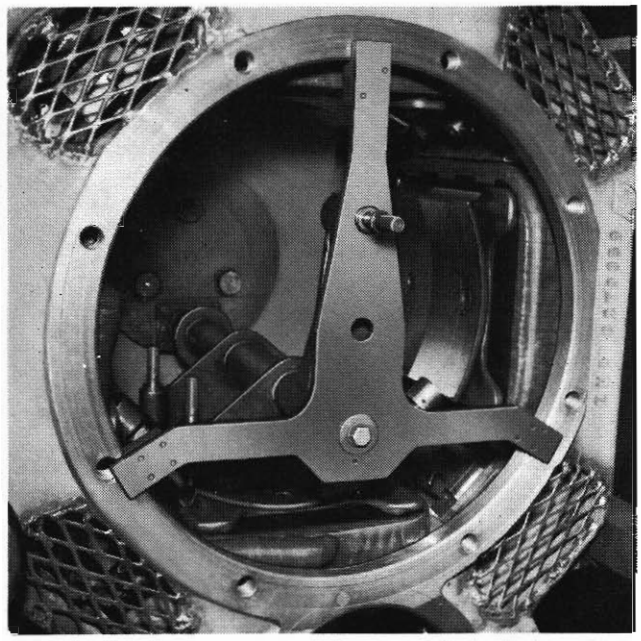

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Fig. 9 – Aligning Fixture In Position

Use two line-up pins to properly position the No. 4 main field coil in frame. Refer to Service Data for line-up pin part number. When coil is positioned the line-up pins are to be removed and two bolts applied. These bolts are to be tightened only enough to hold the coil in place. The bolts will be torqued after the coils have been spaced.

When applying lockwashers and nuts to No. 3 main field coil, place a small amount of caulking compound in the gap in lockwasher. The compound is necessary to provide a seal against moisture. Refer to Service Data for caulking compound part number.

ALIGNMENT OF NO. 4 MAIN FIELD COIL

The No. 4 main field coil is aligned by using adjusting screws and a line-up gauge. Refer to Service Data for tool part numbers. Align the No. 4 main coil assembly as follows:

1. Insert the aligning fixture through the pinion end housing bore over the coil and secure fixture at the commutator end by three lock screws. Position the fixture by locating it in the axle side brush holder block and the pinion end housing bore, Fig. 9. Ensure mating surfaces of the fixture and the stator frame are clean and free of nicks to ensure proper alignment. Rotate fixture with the coil at the bottom.

2. Place adjusting screws between the pole piece and the adjacent pieces.

3. Check alignment of the coil by inserting checking pin through the holes located in the line-up gauge. Shift coil as necessary by using the adjusting screws.

4. When the coil is properly aligned to the fixture, tighten the two pole bolts and remove the adjusting screws. Lubricate Models D29, D31, and D36 bolts with Texaco Threadtex.

5. Recheck alignment, and if still satisfactory, torque both bolts to 610 to 881 N·m (450 to 650 ft-lbs) on Model D19 and to 407 to 441 N·m (300 to 325 ft-lbs) on other models. Tighten bolts a minimum of three passes.

6. Recheck alignment and if still satisfactory, rotate coil to bottom position and remove line-up fixture.

SPACING MAIN FIELD POLES

CAUTION: Do not move No. 4 main field coil during spacing operation. No. 4 coil is positioned and all other spacing is done using the No. 4 coil as a starting point.

Main field coil 3, 2, and 1 are spaced in relation to the No. 4 main field coil, using a gauge and jack, Fig. 10. Refer to Service Data for gauge and jack part number.

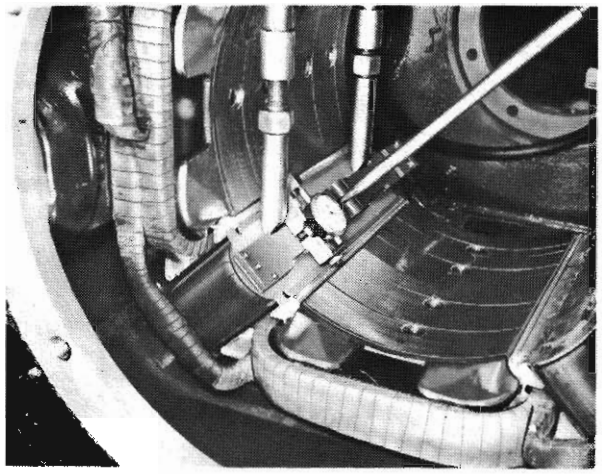

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Fig. 10 – Spacing Main Field Coil

The space between the edges of main field pole is measured 63.5 mm (2-1/2") in from the end of the laminations. The maximum variation between all poles is 0.76 mm (.030"). The centerline of the main pole should not vary from nominal centerline by more than 0.38 mm (.015").

1. Place adjusting screws between the pole to be spaced and adjacent poles. Place adjusting screws between the pole pieces.

2. Shift pole being spaced as necessary by using adjusting screws.

3. Check the clearance between sides of pole and air baffle, Fig. 11. Minimum clearance shall be 2.4 mm (3/32").

4. When main field coils are spaced, remove adjusting screws and baffle locating fixtures.

5. Tighten both bolts of the No. 1, 2, and 3 main field coils to 610 to 881 N·m (450 to 650 ft-lbs) on Model D19 stators and to 542 to 881 N·m (400 to 650 ft-lbs) on other model stators. Lubricate bolts on models other than D19 with Texaco Threadtex.

6. Measure the air gap between opposite main field coils at the pinion end and commutator end of the poles and at the pole center, Fig. 11. The dimensions should be as follows:

At Pinion End And Commutator
End Pole Ends - Max. 489.71 mm (19.280")
Min. 488.19 mm (19.220")

At Center Of Pole - Min. 488.82 mm (19.245")

HIGH POTENTIAL TEST

1. Make temporary connections between main field coils with battery clips or similar clamps to hold the coil leads together.

2. Apply positive electrode of high potential tester to external coil lead connection of either the No. 3 or No. 4 coil and the negative electrode to the frame.

3. On repaired stators, including partial coil replacement, apply high potential test at 3200 volts for 1 minute at ambient temperature.

   On completely rewired stators, apply 4200 volts for 10 seconds at ambient temperature.

4. Discharge coils to ground. Remove clips or clamps.

BRAZING MAIN FIELD COIL CONNECTIONS

1. Index stator frame so that the connection to be brazed between the No. 1 and No. 4 main coil is at the bottom position.

2. Align bottom lead of No. 4 and bottom lead of No. 1 coil so that lead ends are parallel and as close together as possible. Position leads to ensure maximum surface contact with an overlap of 25 mm (1") of mating surfaces. Ensure leads are kept clear of frame.

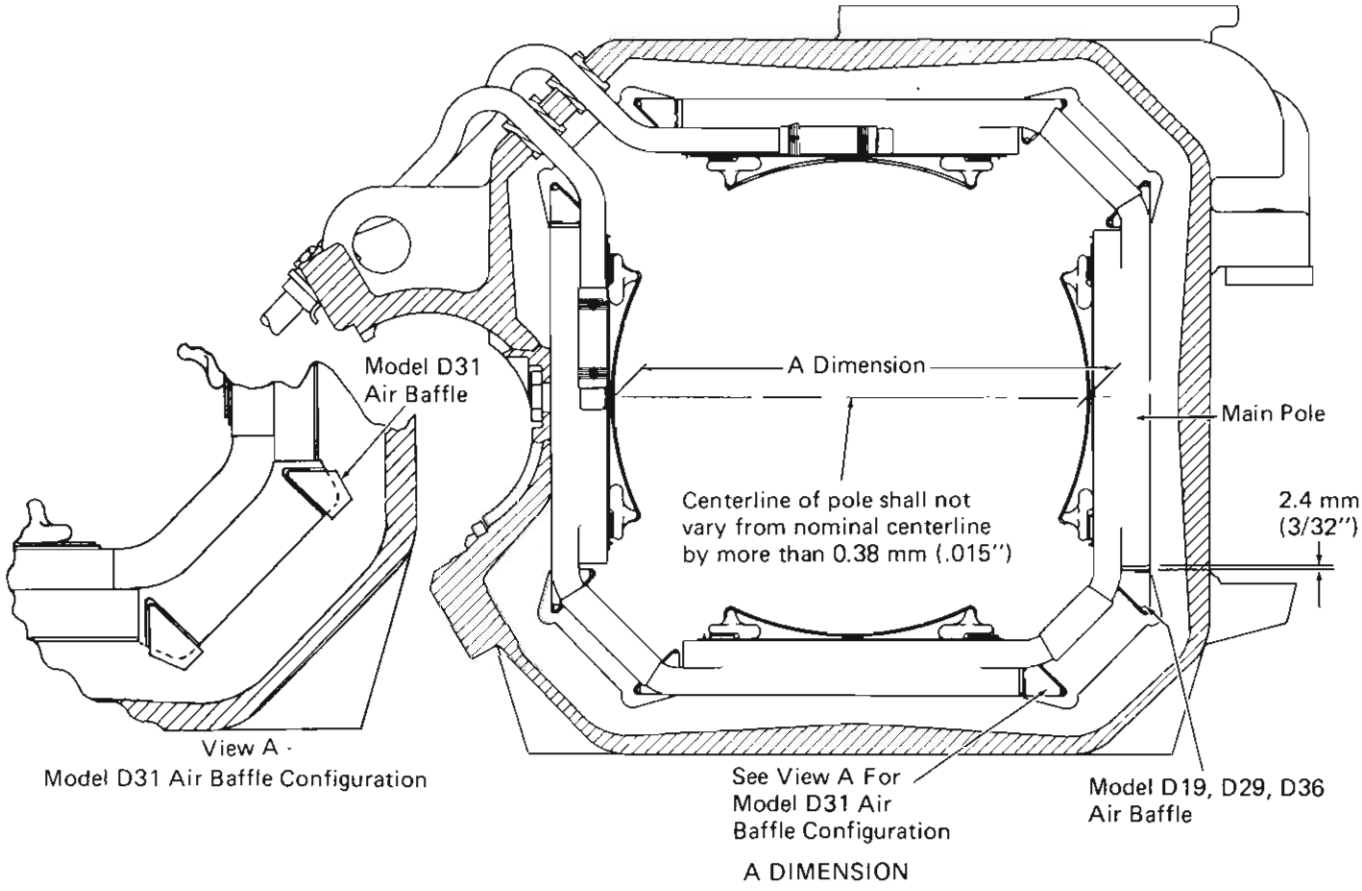
3. Apply flux to lead and lug and insert a piece of silver brazing solder between lead and lug.

4. Position brazing equipment over surface to be brazed and clamp joint together.

5. Actuate transformer to braze the joint together, being sure joint gets hot enough so silver solder will flow to obtain a good joint. Add silver brazing alloy to the edges as required as filler.

6. When braze is completed, wait until solder has definitely solidified and then remove brazing equipment. Brush joint clean and file off any burrs or sharp projections being careful to protect the coil insulation from the filings.

7. Index the stator frame as required and repeat brazing operation on the connectors between the No. 1 and 2 main field coils and the No. 2 and 3 main field coils.



A DIMENSION

At Pinion End And Commutator End Pole Ends	Max. 489.71 mm (19.280") Min. 488.19 mm (19.220")
At Center Of Pole	Min. 488.82 mm (19.245")

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Fig. 11 - Main Field Coil Air Gap

INSULATING MAIN FIELD COIL CONNECTIONS

Insulate all brazed main field coil connections as follows. Refer to Service Data for material part numbers.

1. Insulate all connections between main field coils and all connector terminations to main field coils with one layer of silicone rubber tape half lapped. Start taping one tape width before the joint, and finish one tape width beyond the joint. Tape overall with one layer half lapped of glass adhesive tape. Start and finish glass tape one half the tape width beyond the silicone rubber tape.

NOTE: The silicone rubber tape must be kept in plastic containers until ready for application. This is a self-vulcanizing tape and must be kept free of dirt and not handled excessively before or during application. Connector and cable surfaces to which tape is applied must be clean.

2. If insulation at lead areas of main field coil is cracked or damaged during lead alignment for brazing, repair cracks or damage with RTV compound.

INSTALLING INTERPOLE COILS

The interpoles are installed in a manner similar to the main field coils. The interpoles are installed with a lifting fixture and positioned with guide pins. The poles are spaced between the main field coils using a spacing gauge and an adapter. Air gap is then checked to ensure proper clearance will exist between the armature and the poles.

The interpole coils are identical and may be placed in any interpole position. Connections between the four coils determine the proper polarity.

1. Index stator frame fixture so the location for the No. 2 interpole coil is at the top position. Refer to Fig. 12.
2. Using lifting fixture, position interpole coil leads so that coil leads are towards the commutator end of the stator frame and the bolt holes are up.
3. On the end of the interpole coil, opposite from the leads, observe either the number taped to the end of the coil or the vertical paint marks (paint marks are on the older models). This number or vertical paint marks indicate the number of shims required with the interpole coil. The number includes one 0.51 mm (.020") insulated washer and the remainder of the number in 0.607 mm (.0239") steel shims. The number "4" would indicate one insulated washer and three steel shims. The shims are required to maintain a

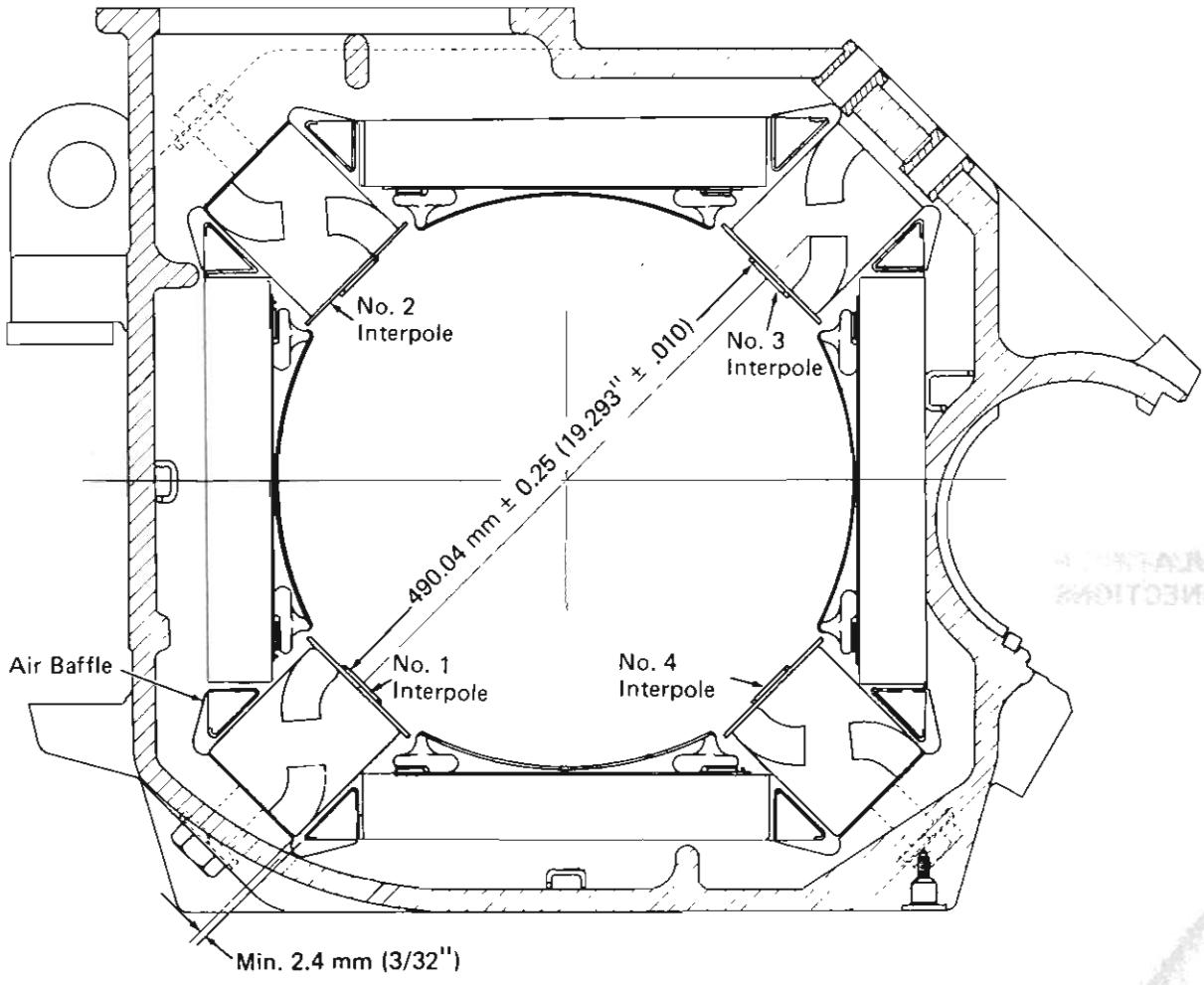


Fig. 12 – Interpole Coil Positions From Commutator End

tight coil. Add only the amount specified, making certain that all shims are aligned centrally on the coil and do not overlap onto the pole piece. Refer to Fig. 13.

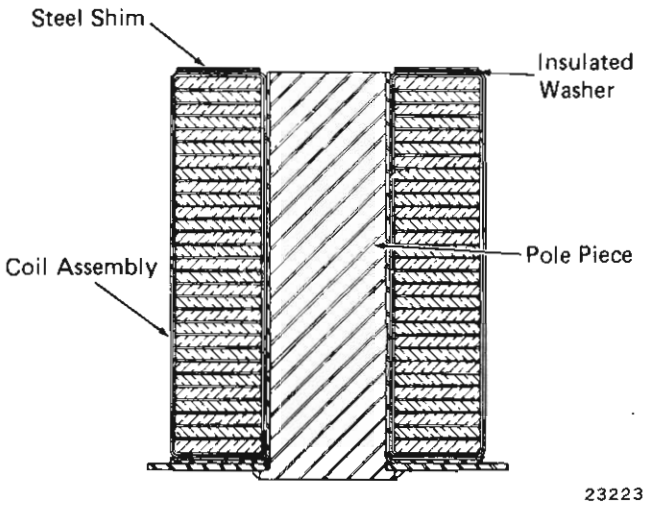


Fig. 13 – Interpole And Coil Assembly

4. Install two temporary aligning studs into pole piece bolt holes. Place one brass shim over these studs and on top of the steel shims (if steel shims were required). The brass shim is necessary to obtain proper air gap between opposite coil pole pieces.

5. Using the coil lifting fixture, insert the coil assembly through the pinion end housing bore, aligning studs on the coil with the bolt holes in the frame. Raise the coil assembly into position, making certain all shims are properly positioned.

NOTE: If the shims are permitted to get between the pole piece and the frame, the air gap between opposite interpole coil assemblies will be undersize.

6. Supporting the coil in position with the lifting fixture, remove the temporary aligning studs and install two pole bolts and two lockwashers. Temporarily tighten the bolts and remove the lifting fixture. Lubricate Model D29, D31, and D36 bolts with Texaco Threadtex.

7. Index stator frame as necessary to install the three remaining interpole coil assemblies. Ensure the coil leads face the commutator end of the frame.

SPACING INTERPOLE COILS

The interpole coil assemblies are spaced in relation to the adjacent main field coils. The centerline of each interpole shall not vary from nominal centerline of the main field coils by more than 0.38 mm (.015"). The maximum allowable skew is 0.38 mm (.015").

1. Use interpole jack as necessary to properly space and align interpole coil assemblies. Take measurements approximately 38 mm (1-1/2") from both ends of the pole pieces of adjacent main field coils.

CAUTION: Do not disturb main field coil assemblies when spacing interpole coil assemblies.

2. When interpole coils are properly spaced, check the space between the interpole coils and the air baffles, Fig. 12. Minimum allowable clearance is 2.4 mm (3/32") except that 0.25 mm (.010") clearance is allowed between interpole leads and adjacent air baffle.

3. Tighten Model D19 interpole coil bolts to 610 to 881 N·m (450 to 650 ft-lbs) and Model D29, D31, and D36 interpole coil bolts to 542 to 881 N·m (400 to 650 ft-lbs). Lubricate Model D29, D31, and D36 interpole coil bolts with Texaco Threadtex.

4. Check the air gap between opposite interpole pole pieces. Measure pole at each end. The distance between opposite interpoles should be 490.04 mm ± 0.25 (19.293" ± .010"), Fig. 12.

HIGH POTENTIAL TEST

1. Make temporary connections between interpole coils with battery clips or similar clamps. Connect the bottom coil leads of the No. 3 coil and No. 4 coil together. Connect the top leads of the No. 4 coil and No. 1 coil together. Connect the bottom leads of the No. 1 coil and No. 2 coil together.

2. Apply positive electrode of high potential tester to external lead connection of the No. 3 interpole coil and the negative electrode to the frame.

3. Apply high potential test of 3200 volts for 1 minute at ambient temperature.

4. Discharge coils to ground. Remove clips or clamps.

BRAZING INTERPOLE COIL CONNECTIONS

1. Index stator frame fixture so that No. 2 interpole coil is at the bottom position.

2. Position one long coil connector assembly between the stator frame side leads of the No. 1 and No. 2 interpole coil so that the short bent end of the coil connector rests under the stator frame side lead of the No. 2 interpole coil as shown in Fig. 14. Temporarily clamp the other end of the coil connector to the frame side lead of the No. 1 interpole coil.

NOTE: Position leads to ensure maximum surface contact of cable terminal lugs or coil connectors.

3. Apply flux to lead and connector at No. 2 interpole coil and insert silver brazing piece between lead and connector. Move brazing equipment into position from the commutator end of stator frame.

4. Position brazing equipment over surface to be brazed and clamp joint together, ensure joint gets hot enough so silver solder will flow to obtain a good joint. Add silver brazing alloy to the edges as required as a filler.

5. When braze is completed, wait until solder has definitely solidified and remove brazing equipment. Brush joint clean.

6. While stator frame is still in this position, install "AA" lead through grommet in stator frame and position the 25 mm (1") flat surface of lead terminal lug against bottom armature side of the coil lead for the No. 2 interpole coil. Braze connection.

7. Remove brazing equipment and index stator frame so No. 1 interpole coil is in the bottom position.

8. Remove the temporary clamp holding connector to the No. 1 interpole coil and braze the connection.

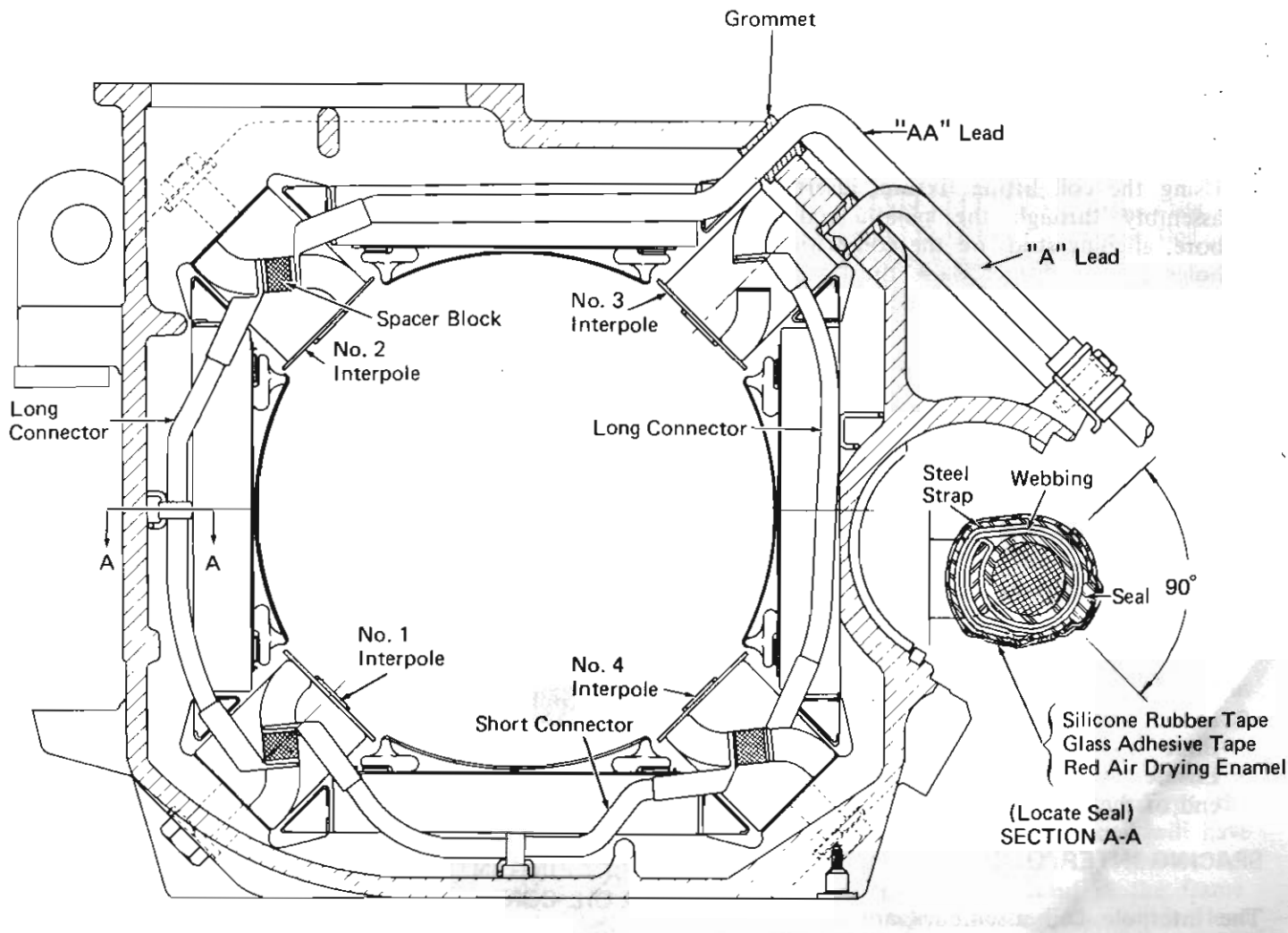


Fig. 14 – Interpole Coil Connection From Commutator End

9. While stator frame is in this position, install a short coil connector assembly between the No. 1 and the No. 4 interpole coils. Place the long bent end of the coil connector on top of the armature side coil lead of the No. 1 interpole coil and the other end of the short bent end of the coil connector on the armature side lead of the No. 4 interpole coil as shown in Fig. 14. Temporarily clamp the other end of the coil connector to the No. 4 interpole coil connection. Braze the connection at the No. 1 interpole.

10. After the solder has solidified, remove the brazing equipment and index the stator frame fixture so the No. 4 interpole coil is at the bottom position.

11. In the same manner as in Step 9, install a long coil connector between the frame side leads of the No. 4 and No. 3 interpole coil and place this connector on the frame side of the leads. Position stator frame as necessary and braze connections.

INSULATING INTERPOLE COIL CONNECTIONS

1. Insulate the brazed connections between interpole coils and connections to the interpole coils with two layers of silicone rubber tape half lapped. Start taping two tape widths before the joint, tape over the joint, and finish two tape widths beyond the joint. Tape overall with one layer half lapped of glass adhesive tape. Start and finish glass tape one half the tape width beyond the silicone rubber tape.

2. If insulation at lead areas of interpole coils is cracked or damaged during lead alignment for brazing, repair cracks or damage with RTV compound.

3. Insert a spacer block between the two taped connections of the interpole coil leads, Fig. 14, and tape securely together with glass adhesive tape. Cover the tape on the interpole coil leads and extend one to two tape widths beyond the lug barrels of the cables. During painting of the stator, ensure the tape is covered with red air drying enamel.

4. Wrap the short connector between interpole coil No. 1 and No. 4 and the long connector between interpole coil No. 1 and No. 2 with webbing and secure to "saddle" on the bottom and side of frame as shown in Section A-A of Fig. 14. Tighten and cut steel strap with a steel binder set. Lock strap with strap seal and remove steel binder set. Wrap the steel strap with two layers of silicone rubber tape. Secure the silicone rubber tape with one layer of glass adhesive tape. Refer to Service Data for webbing, steel binder set, and tape part numbers.

INSTALLATION OF BRUSH HOLDER CROSS CONNECTORS

1. When using new cables, install dummy brush holders to form cables to prevent damage to the motor brush holders. Refer to Service Data for dummy brush holder part number. If installing used, formed cables, install motor brush holders.

2. Install either dummy brush holders or motor brush holders to the axle side and side opposite axle, Fig. 15.

3. Position and connect brush holder cross connector from the armature side of the No. 3 interpole coil lead to the holder opposite the axle side.

4. Position and connect brush holder cross connector from the armature side of the No. 3 interpole coil lead to the axle side brush holder.

NOTE: There are two brush holder cross connectors at the armature side of the No. 3 interpole coil lead.

5. Braze both connector leads to the No. 3 interpole coil lead.

6. Insulate the connection with two layers of silicone rubber tape half lapped. Start the tape 38 mm (1-1/2") from the end of the connector, tape over the cable, and finish taping around lug radius. Tape overall with one layer of glass adhesive tape half lapped.

7. Install "A" lead and cross connector assembly through grommet in frame.

8. Assemble brush holder or dummy brush holder to connectors at the ends of "A" lead. Position brush holders or dummy brush holders in top and bottom brush holder blocks. Position brush holder cross connectors as shown in Fig. 15.

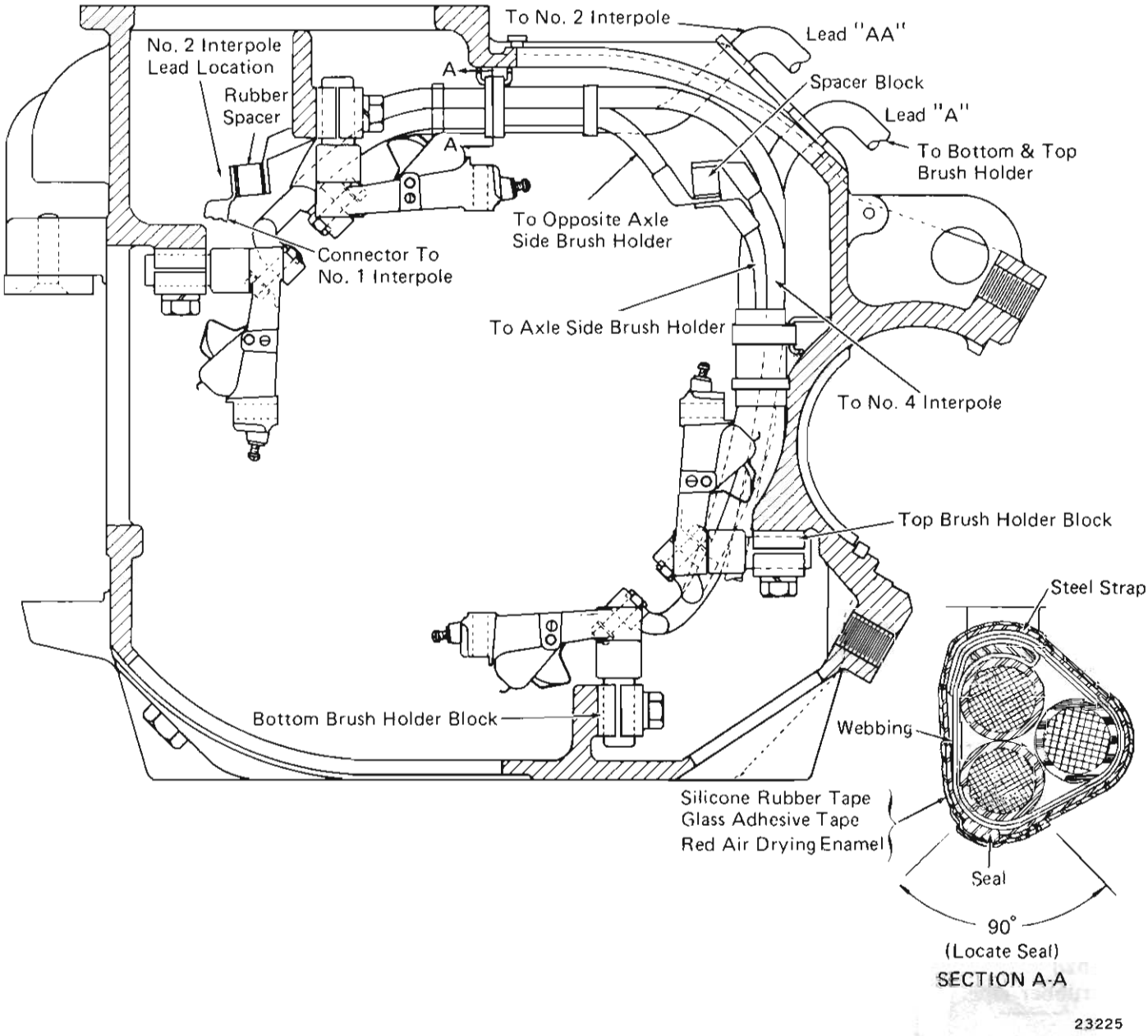


Fig. 15 - Brush Holder Cross Connectors

NOTE: At least 6 mm (1/4") clearance must be maintained between the bottom brush holder cross connector and the No. 4 interpole coil lead insulation, and between the suspension side brush holder cross connector and the No. 2 interpole coil lead insulation. The cables may be tied together to maintain this clearance.

9. Insulate the cable connection of the "A" cable with one layer of half lapped pressure sensitive glass tape over the connector. Finish taping approximately 25 mm (1") beyond the edge of cable insulation. Apply the glass tape so it will conform tightly to the contour of the connection.

   Over the glass tape, apply two layers of half lapped silicone rubber tape, slightly overlapping both ends of the glass tape. Silicone rubber tape must be applied snugly, but stretched only sufficiently to ensure a tight joint.

   Apply one layer of half lapped pressure sensitive glass tape, overlapping the ends of the silicone rubber tape. During painting of the stator, ensure the tape is covered with red air drying enamel.

10. Secure the brush holder cross connectors in five places as shown in Fig. 15. Wrap the leads with webbing and apply steel strap.

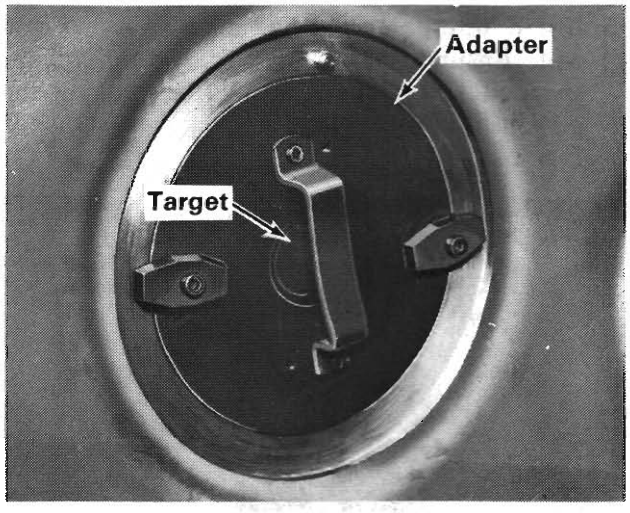
Secure steel strap to "saddles" where shown in Fig. 15. Tighten and cut steel strap with a steel binder set. Lock strap with the strap seal and remove steel binder set. Wrap the steel strap with two layers of silicone rubber tape. Secure the silicone rubber tape with one layer of pressure sensitive glass tape.

11. Remove dummy brush holders, if used, and install motor brush holders.

MICRO-ALIGNMENT TELESCOPE CHECK OF STATOR POLES AND BRUSH HOLDERS

NOTE: Refer to Service Data for file number of adapters and tools required to check pole and brush holder alignment.

1. Insert adapter with target in commutator end bore, Fig. 16. Ensure cross hairs of target are horizontal and vertical.



23226

Fig. 16 – Commutator End Adapter

2. Install pinion end telescope adapter in pinion end bore, Fig. 17.

3. Insert micro-alignment telescope into center hole of pinion end telescope adapter, Fig. 17. Set both telescope micrometers to zero. Adjust telescope adapter so that cross hairs of telescope line up perfectly with commutator end adapter target cross hairs. This check is made to ensure pinion end adapter is concentric and square to commutator end adapter.

4. Install brush holders to brush holder blocks. Insert a gauging unit pin into both brush slots of the No. 4 brush holder, Fig. 18. Refer to Fig. 19 for brush holder No. 4 position.

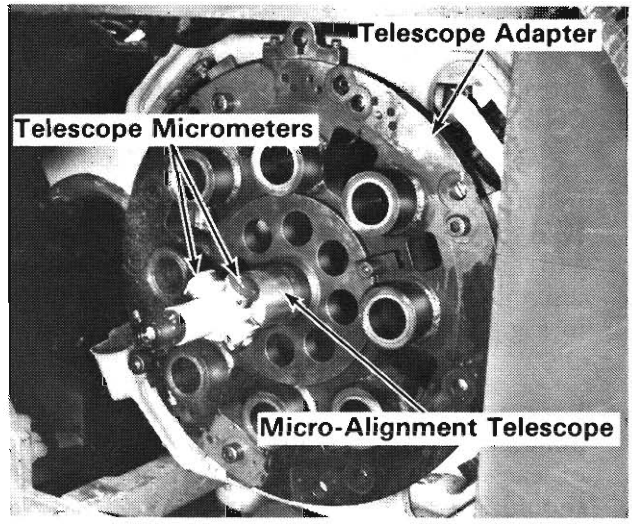


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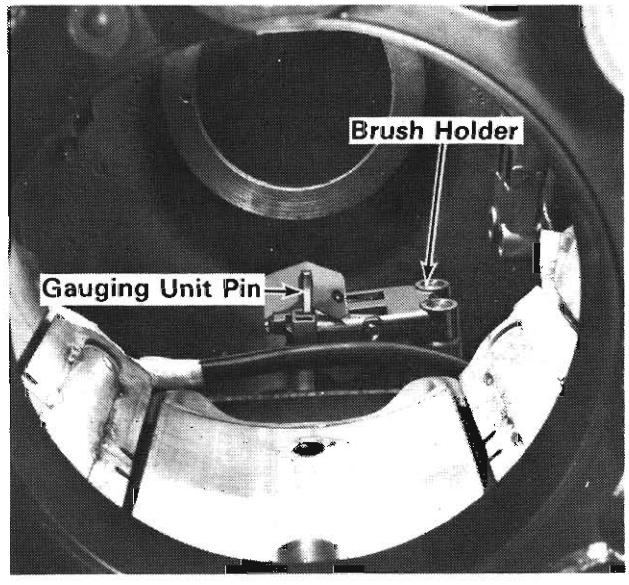
Fig. 17 – Pinion End Telescope Adapter With Telescope



23228

Fig. 18 – Brush Holder Alignment Pin

NOTE: A piece of paper or cardboard placed behind pin, as shown in Fig. 18, will outline pin for a more accurate telescope reading.

5. Insert telescope into appropriate hole of pinion end telescope adapter to take telescope reading at right side of gauging unit pins in No. 4 brush holder slots. Record micrometer reading. The pinion end reading of the No. 4 brush holder is used as a reference for the other three brush holders, the four main field coils, and the four interpole coils.

6. Check the remaining three brush holders using a gauging unit pin in both brush holder slots. The centerline through the No. 2 and No. 4, and No. 1 and No. 3 brush holder brush slots shall not vary from nominal centerline by

more than 0.25 mm (.010"), Fig. 19. The maximum skew on any one brush holder, measured at the brush slot, shall be 0.20 mm (.008").

7. Install main pole spacing gauge over main field coil. Ensure gauge is centered over coil and snapped snugly in place. Place gauging unit pin in main pole spacing gauge as shown in Fig. 20.

8. Insert telescope into appropriate hole of pinion end telescope adapter to take a reading of each main field coil. Each main field coil should be within ± 0.38 mm (.015") of telescope reference reading taken at No. 4 brush holder brush slot. The maximum skew of any one main field coil is 0.38 mm (.015"). If main field coil is not within tolerance, loosen both bolts and re-align main field coil. Tighten both bolts to 610 to 881 N·m (450 to 650 ft-lbs) on Model D19 stators and 542 to 881 N·m (400 to 650 ft-lbs) on other models. Lubricate bolts on models other than D19 with Texaco Threadtex.

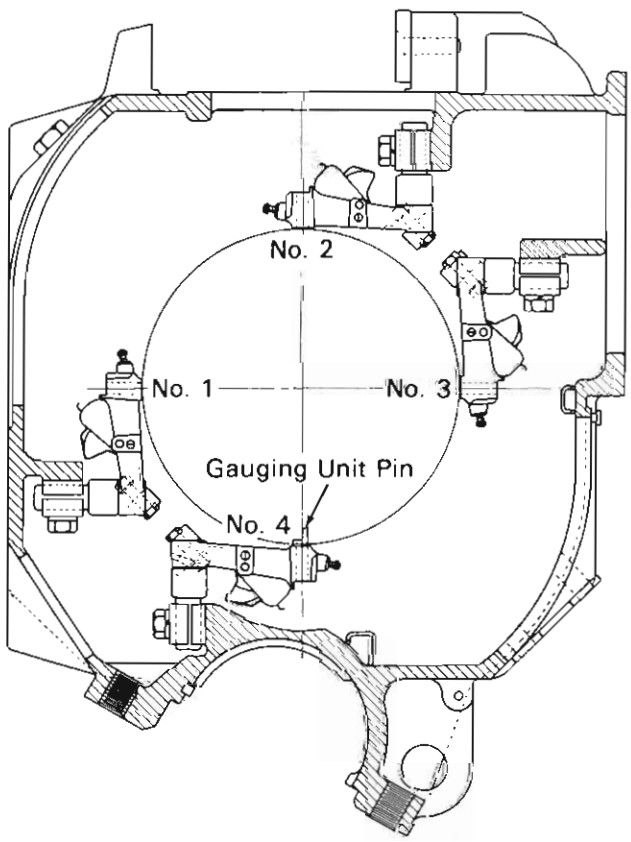


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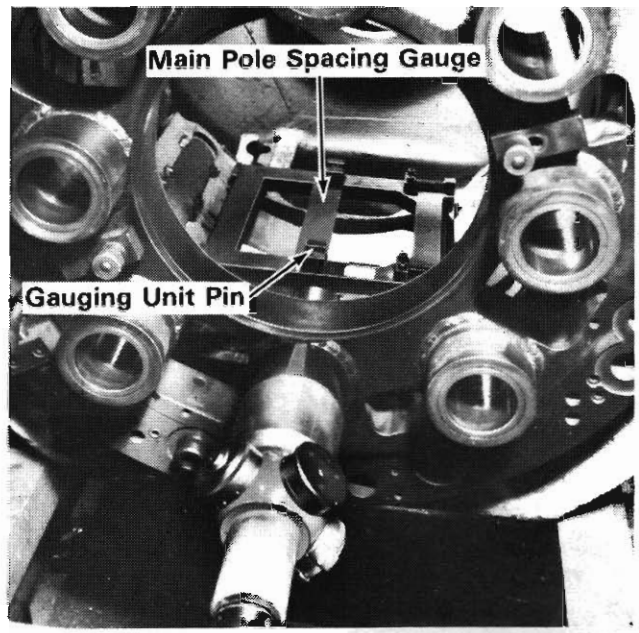
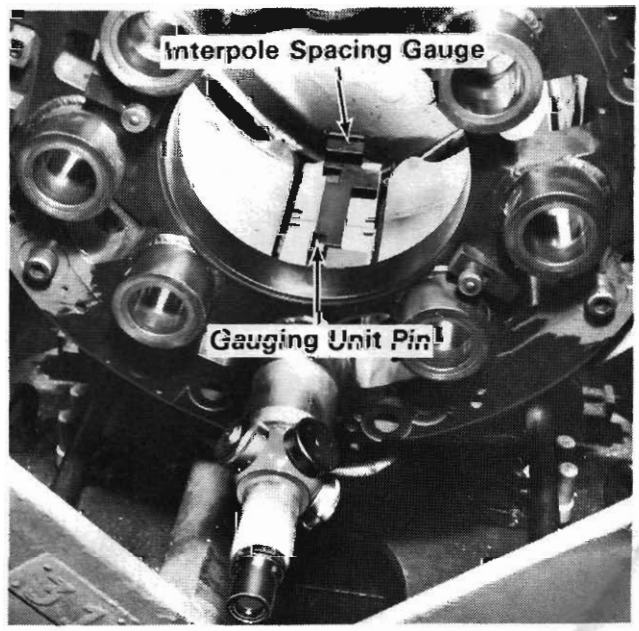
Fig. 19 – Brush Holder Positions From Commutator End



23230

Fig. 20 – Main Pole Spacing Gauge

9. Install interpole spacing gauge over interpole coil. Ensure gauge is centered over coil and snapped snugly in place. Place gauging unit pin in interpole spacing gauge as shown in Fig. 21.



23231

Fig. 21 – Interpole Spacing Gauge

10. Insert telescope in appropriate hole of pinion end telescope adapter to take a reading of each interpole coil. Each interpole coil should be within ± 0.38 mm (.015") of telescope reference reading taken at No. 4 brush holder brush slot. The maximum skew of any one

interpole coil is 0.38 mm (.015"). If interpole coil is not within tolerance, loosen interpole coil bolts and re-align interpole coil. Tighten bolts to 610 to 881 N·m (450 to 650 ft-lbs) on Model D19 stators and 542 to 881 N·m (400 to 650 ft-lbs) on other models. Lubricate bolts on models other than D19 with Texaco Threadtex.

FINAL ASSEMBLY

1. Mask the contact surface and bolt seat of the four terminal lugs and paint the following areas with red air drying enamel. Refer to Service Data for enamel part number.

   a. Brush holder cross connectors

   b. Terminals and leads

   c. Strapping (or roping, if used)

   d. Inside of frame around brush holders

2. Remove masking. Refer to Fig. 22 for completed stator.

3. Fasten motor leads together in pairs with insulation strips and steel straps on outside of frame, two ties per pair of leads, 76 to 89 mm (3 to 3-1/2") apart, approximately half way between grommets and cable cleat as shown in Fig. 23. Tighten and cut steel strap with a steel binder set. Lock strap with the strap seal and remove steel binder set.

4. Fill cavity between rubber grommets and cables with caulking compound. Refer to Service Data for caulking compound and steel binder set part number.

5. Seal around top main pole bolts and lockwashers with a liberal coating of liquid neoprene. Refer to Service Data for liquid neoprene part number.

HIGH POTENTIAL TEST

Refer to High Potential Test Apparatus and High Potential Test Procedure portions of this section.

On a repaired stator, including partial coil replacement, apply a high potential test to the completed stator of 3200 volts for 1 minute at ambient temperature.

On a completely rewired stator, apply a high potential test of 4200 volts for 10 seconds at ambient temperature.

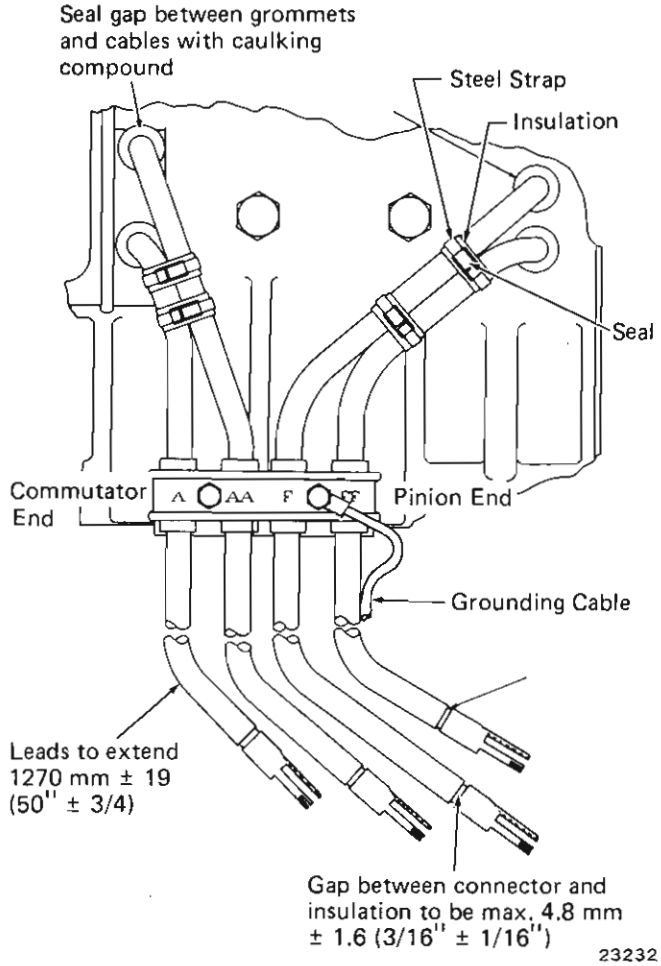


Fig. 22 – External Lead Arrangement

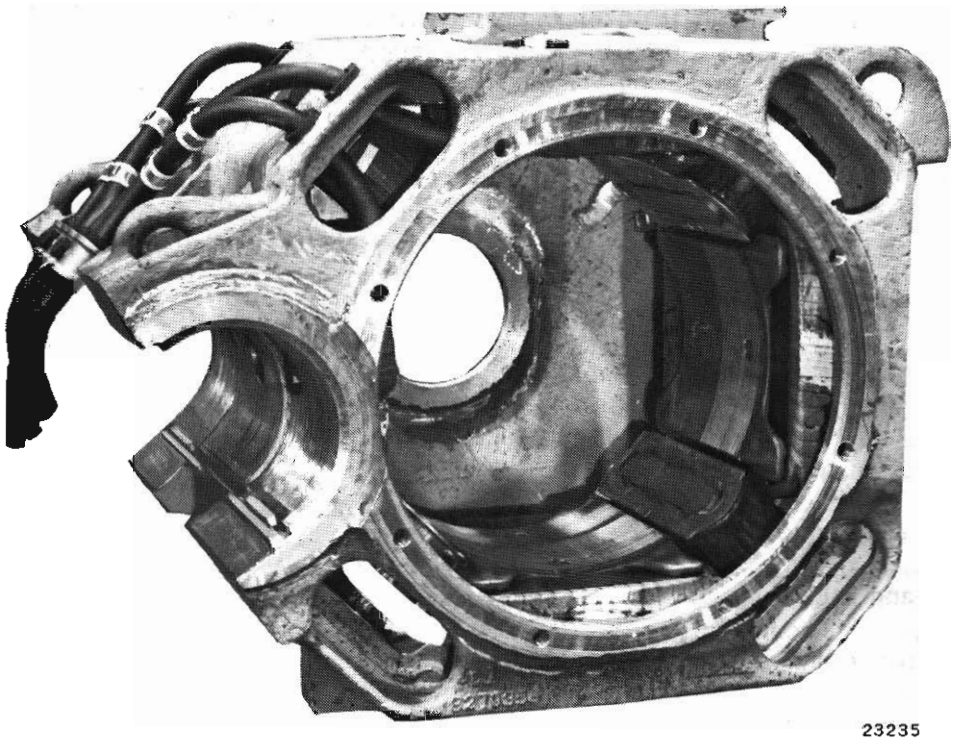


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Fig. 23 – Completed Stator

SERVICE DATA

EQUIPMENT AND MATERIAL LIST

EQUIPMENT

Stator Frame Positioning Fixture	8285821
Lifting Device	8285822
Interpole Coil Lifting Fixture	8285823
Main Field Coil Lifting Fixture	8285824
Outer Air Baffle Positioning Fixture (4 req'd)	8300666
Main Field Coil (No. 4) Lineup Gauge	8300667
Lineup Pins	8287283
Main Field Coil Adjusting Screws (2 req'd)	8285830
Main Field Coil Spacing Jack (2 req'd)	8285832
Interpole Coil Jacking Screw (2 req'd)	8285843
Dummy Brush Holder	8300665
Brazing Equipment	8261812
Thermo-Grip Pliers	8064918
Megger, Insulation Resistance	8174880
Leads, 4 m (12') Long	8174878
Case, Carrying	8174879
Grounding Cable	8351902
Axle Cap Simulator	File No. 888
Pinion End And Commutator End Telescope Adapter And Micro-Alignment Telescope	File No. 900
Main Pole And Interpole Spacing Gauges And Gauging Unit Pins	File No. 991

NOTE: File number represents a facility drawing that is available (at no charge) from EMD Service Department. This drawing includes construction details of tooling that can be manufactured by the customer.

MATERIAL

Brazing Strip, Silver, 25 mm x 25 mm x 0.3 mm (1" x 1" x .010")	8140503
Caulking Compound, 0.7 kg (1-1/2 lb) Can	8198204
Enamel, Red Air Drying	
1 litre (1 qt)	8061130
19 litre (5 gal)	8048876
Flux, Brazing, Low-Temp, 0.5 kg (1 lb)	8116442
Flux, Solder, 0.5 kg (1 lb)	8122570
Neoprene, Liquid, 3.79 litre (1 gal)	8213281
RTV, Silicone Compound, 170 g (6 oz) Cartridge	8345495
Solder, Tin Base, No. 8 Wire, Approx. 23 kg (50 lb) Spool	8225761
Solder, Pure Tin, 7.3 kg (16 lbs)	8069984
Steel Binder Set	8285846
Tape, Glass Adhesive, 33 m (36 yds) Roll	8395904
Tape, Silicone Rubber, 0.50 mm x 25 mm (.020" x 1") Roll	8355873
Threadtex, Texaco, 18.93 litre (5 gal)	8307731
Tubing, Heat Shrinkable, 38 mm dia. x 76 mm lg. (1-1/2" x 3")	8352037
Twine, Torpedo -	
2 mm (3/32") Diameter, 0.5 kg (1 lb) Ball	8133163
2 mm (3/32") Diameter, 4.5 kg (10 lb) Spool	8173162
2 mm (3/32") Diameter, 22.7 kg (50 lb) Spool	8143785
Webbing, Rubber Coated, 1.6 mm x 25.4 mm x 508 mm (1/16" x 1" x 20")	8351344