C.M.I. 3954-4

CLYDE MAINTENANCE INSTRUCTION

D43 TRACTION MOTOR OVERHAUL

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SECTION 4
STATOR INSPECTION AND RECONDITIONING ELECTRICAL

NOTE

This D43 Traction Motor overhaul instruction is presented in seven sections, each under separate cover, and contains detailed instructions to completely disassemble, inspect, overhaul, assemble, and test the traction motor.

Refer to maintenance Instruction, CMI 3901, for general or "running" maintenance of the traction motor and also for procedures to remove the traction motor from the locomotive truck

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 85 g 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. Two steam guns are required such as Hurriclean Steam Guns, Model 551.

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 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.

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 .

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 minimum. The condemning length of the external cable length with lug is 1,253 mm - 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 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.

5. On traction motor stators, 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. 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.

7. 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 with a reflector, Fig. 2. Apply heat to the centre of the tubing and work toward one end. Apply heat again to the centre of the tubing and work toward the opposite end. This procedure will assure an equal distribution of the longitudinal shrinkage. Apply heat only long enough to allow tubing to assume contour of the cable. Application of additional heat will serve no useful purpose.

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

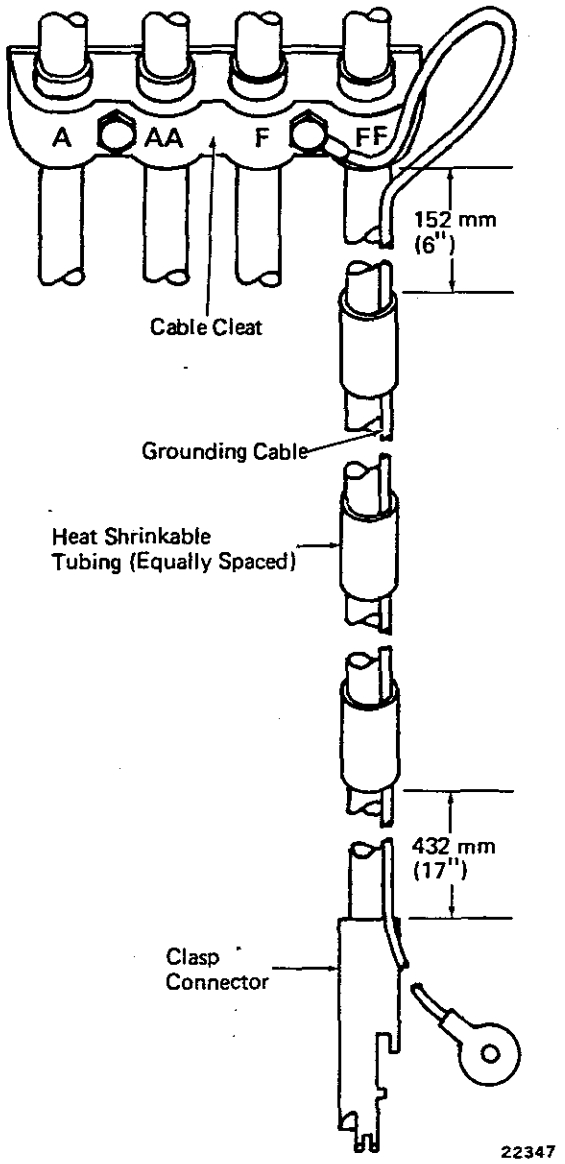

Fig. 1 - External Lead Grounding Cable

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 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:

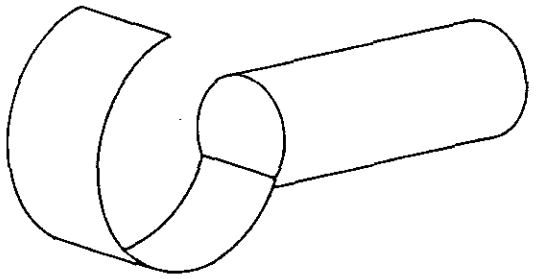

Fig. 2 - Heat Gun Reflector

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 thermogrip 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.

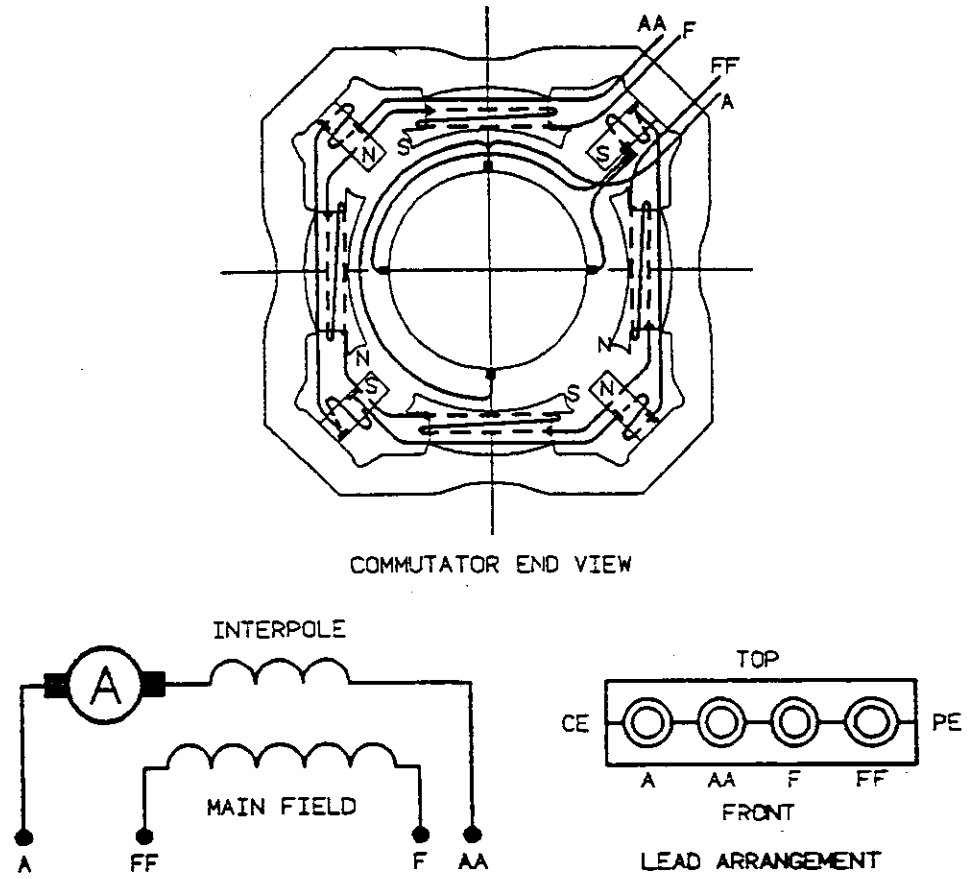

Fig. 3 - Wiring Diagram

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.

MAIN FIELD COIL SHIMMING

Perform the following procedure to ensure the coils are tight.

1. Measure and record the distance from a main field pole to the opposite pole.

2. Loosen one main field pole (of the measured pair) and place one 0.25 mm shim on both sides of the coil between the coil and frame and/or between the coil and shield. Ensure the coil is held tightly in place to prevent damage to the coil insulation when steel pole is loosened.

3. Tighten the loosened main field pole and again measure the distance from the pole to the opposite pole. Compare with

the first recorded dimension. If the pole was tight, there should be a loss of air gap proportional to the amount shimmed. If the dimension is at least 0.15 mm less than the recorded measurement, the pole can be assumed tight.

If there is no reduction in air gap after shimming, add shims between the coil and frame and/or between the coil and shield until specified reduction in air gap is obtained. Repeat the procedure for the opposite pole (of the measured pair) and also for the remaining pair of coils.

INTERPOLE COIL SHIMMING

When loose interpole coils are found, it is necessary to apply shims between the coil and frame.

Refer to Service Data for shim part numbers.

Shim the interpole coils as follows:

1. Remove interpole coil from stator.

2. Apply shim between the interpole lead and washer on the armature side of the pole and coil assembly. Tape the tail of the shim to the lead with glass tape.

3. Apply shims to produce a tight interpole coil. Tape shims to the coil so that the steel pole will not rest on the shim. Ensure air gap of 478.33 mm + 0.5 mm is maintained.

MAIN POLE AND INTERPOLE SPACING

Check main pole and interpole spacing. Refer to Alignment Of No. 4 Main Field Coil and Spacing Main Field Coils portions of this instruction for main field coil spacing procedure and limits. Refer to Spacing Interpole Coils portion of this instruction for interpole spacing procedure and limits.

BORE OUT-OF-ROUND LIMITS

Check out-of-round condition of the pinion end and commutator end bores after coils are spaced and tightened. The maximum out-of-round limits are as follows.

Condition	Pinion End	Commutator End
Without Pinion End Axle Cap or Simulator	0.53 mm	0.13 mm

If the above limits are exceeded, recheck dimensions with pinion end axle cap or simulator installed. Refer to Service Data for simulator file number. The limits are then as follows.

Condition	Pinion End	Commutator End
With Pinion End Axle Cap or Simulator	0.38mm	0.13 mm

MAIN POLE AIR GAP CHECK

If the main field coils are tight and spaced, check the main pole air gap in the following manner.

Measure the distance between opposite main poles with a gauge. Refer to Service Data for gauge part number. Measure the gap at the pinion end and the commutator end between the pole studs, A of Fig. 4. The dimension should be as shown.

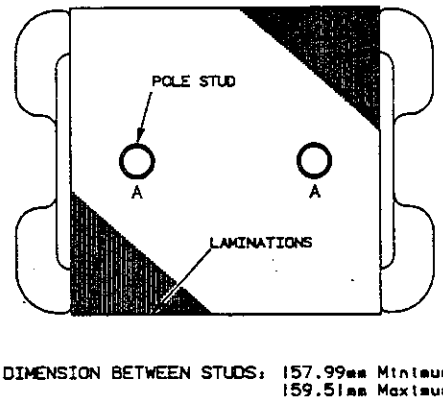

Fig. 4 - Main Pole Assembly

RESISTANCE AND POLARITY 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. 3.

   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^{0} C (167^{0} F) should be as follows:

Main Field	0.0093 ohms $\pm$ 2%
Interpole Field	0.0066 ohms $\pm$ 2%

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.

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. 5.

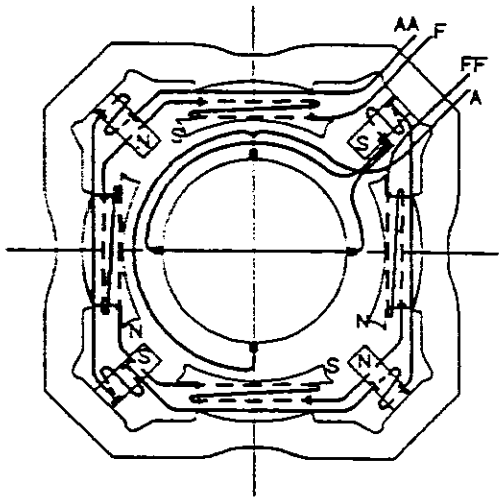

Fig. 5 - Coil Polarities

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

2. Hold the compass at the centre 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.

TESTING MAIN FIELD COILS FOR SHORTED TURNS

COIL INSULATION ANALYZER OPERATION

The main field coils should be checked for shorted turns with a coil insulation analyzer. In the following procedure, operation of a P.J. Coil Insulation Analyzer Model 6920 is described. If another type of coil insulation analyzer is used (which can accomplish equivalent results), this procedure can be used as a guide.

1. Connect analyzer to correct AC power source and set analyzer ON-OFF switch to ON.

2. Turn on oscilloscope. Set switches and levers to positions as indicated by the red or green dots.

   a. Initial setting for voltage amplifiers should be 0.5 volts per division.

   b. Initial setting for time base should be 1 microsecond per division.

3. Adjust time base and voltage amplifiers to obtain maximum oscilloscope trace for ease of viewing.

4. Attach analyzer leads to coils to be tested.

5. When the analyzer yellow READY light comes on after warm-up, the analyzer is ready to operate.

6. Rotate the VOLTAGE ADJUST control counterclockwise to zero.

7. Press the foot pedal high voltage interlock switch. This switch must remain pressed throughout all testing.

8. Press the green TEST button. A red blinking light will come on and the green READY light will go off.

9. Adjust the VOLTAGE control to the proper setting.

Number Of Coils In Series	Test Voltage (Peak Volts)
1	3500
2	7000

GENERAL TESTING SEQUENCE

WARNING: Use extreme caution when operating coil analyzer. The analyzer ground wire is not connected to stator during operation and peak voltages of 7000 volts will be used.

CAUTION:
Do not exceed voltages specified. Excess voltage can result in unnecessary damage to coil or coils under test.

The following test is to be performed with the analyzer ground wire not connected. Ensure the stator has been high potential tested before performing this test.

1. Remove the insulation on the connection between the No. 1 main field coil (bottom) and the No. 2 main field coil (suspension side).

2. Attach one of the analyzer coloured leads to the stator "FF" lead clasp connector and the corresponding black analyzer lead to the uninsulated brazed connection between the remaining analyzer coloured lead to the stator "F" lead clasp connector and the corresponding black lead to the uninsulated brazed connection between the No. 1 and the No. 2 main field coils.

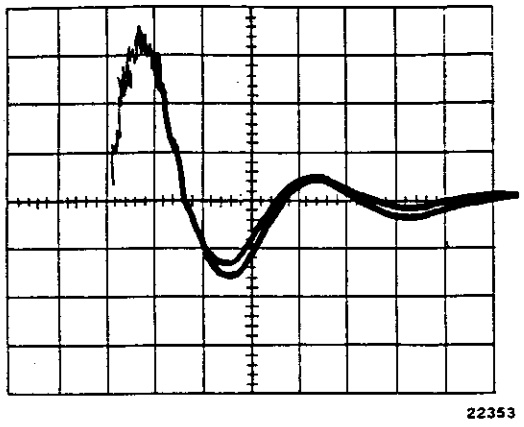

Fig. 6 Oscilloscope Trace - Two Good Coil Sets

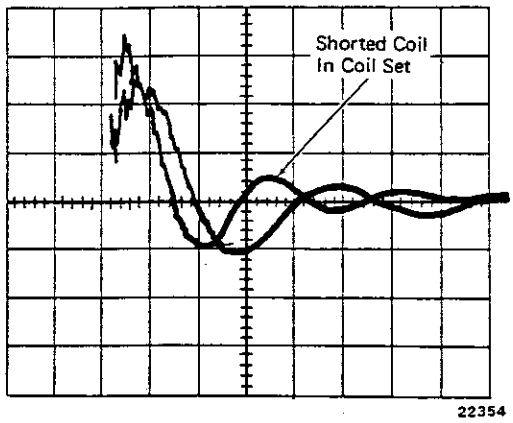

Fig. 7 - Oscilloscope Trace - Shorted Coil of a Coil Set

NOTE: Step 2 is comparing the No. 4 (axle) and No. 1 (bottom) main field coil which are in series to the No. 2 (suspension) and No. 3 (top) main field coils which are also in series.

3. Rotate the VOLTAGE ADJUST control clockwise until the TEST VOLTAGE meter indicates 7000 volts (3500 volts per coil). Adjust the sweep frequency of the oscilloscope to approximately 1 microsecond per division. When both coils are not shorted and no further testing is required, the oscilloscope trace will be similar to Fig. 6. The oscilloscope trace of Fig. 7 indicates a shorted coil. The higher frequency trace is from the shorted coil.

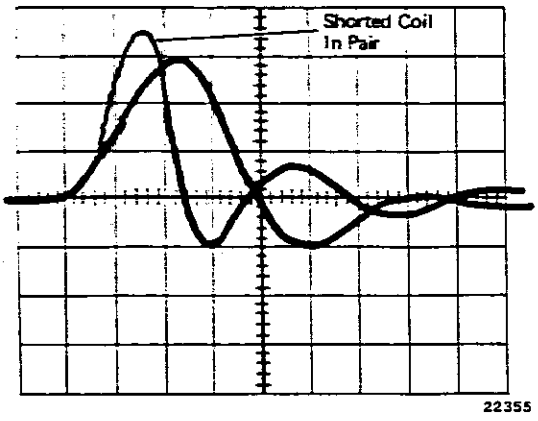

Fig. 8 - Oscilloscope Trace - A Good Coil and a Shorted Coil

By switching the oscilloscope amplifier input AC-DC-GRD switch from DC to GRD and noting the colour coding on the lead to that input, the two coils in series which indicate a short can be determined.

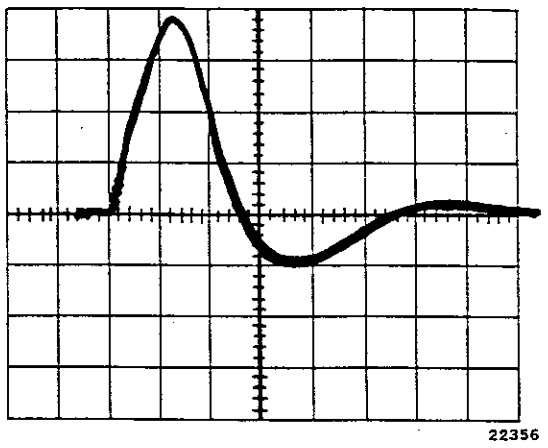

Fig. 9 - Oscilloscope Trace - Two Good Coils

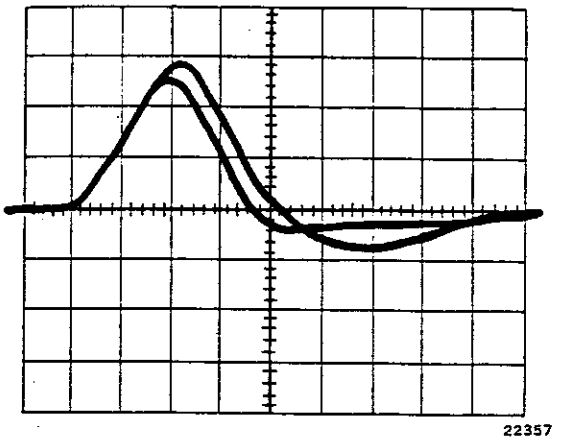

Fig. 10 - Oscilloscope Trace - Normal Differences Between Two Good Coils from Two Different Stators

4. The set of two coils which have been identified as containing the probable shorted coil must now be compared to each other at 3500 volts across each coil. Remove the insulation on the brazed connection between the No. 4 and No. 1 main field coil or from between the No. 2 and No. 3 main field coil. Adjust the sweep frequency of the oscilloscope to approximately 1 microsecond per division.

5. When adjacent coils are under test, the black analyzer leads should be connected at a point common to both coils. If the No. 4 (axle) and No. 1 (bottom) coils are tested (compared with each other), the coloured analyzer leads should be attached at the "FF" clasp connector and at the brazed connection between coils No. 1 and No. 2. The corresponding black analyzer leads are to be connected at the brazed connection between the No. 4 and No. 1 main field coils.

   Fig. 8 shows a good field coil and a shorted field coil. The higher frequency oscilloscope trace would be the shorted field coil. By switching amplifier input AC-DC-GRD switch from DC to GRD and noting the colour coding on the lead to that input, the shorted coil can be determined.

6. If a doubt still remains about which coil is shorted, or if there may be multiple shorts, any coil with an indicated short must be compared with a known good coil at 3500 volts. In some situations, the coils in one stator may have to be compared with coils of another stator. Fig. 9 shows two good (not shorted) coils compared for reference. Fig. 10 shows normal differences which may be noticed when testing a No. 4 main field coil with another coil from a different stator. Both coils are not shorted, but a thinner frame section behind the No. 4 (axle side) coil would account for this variation.

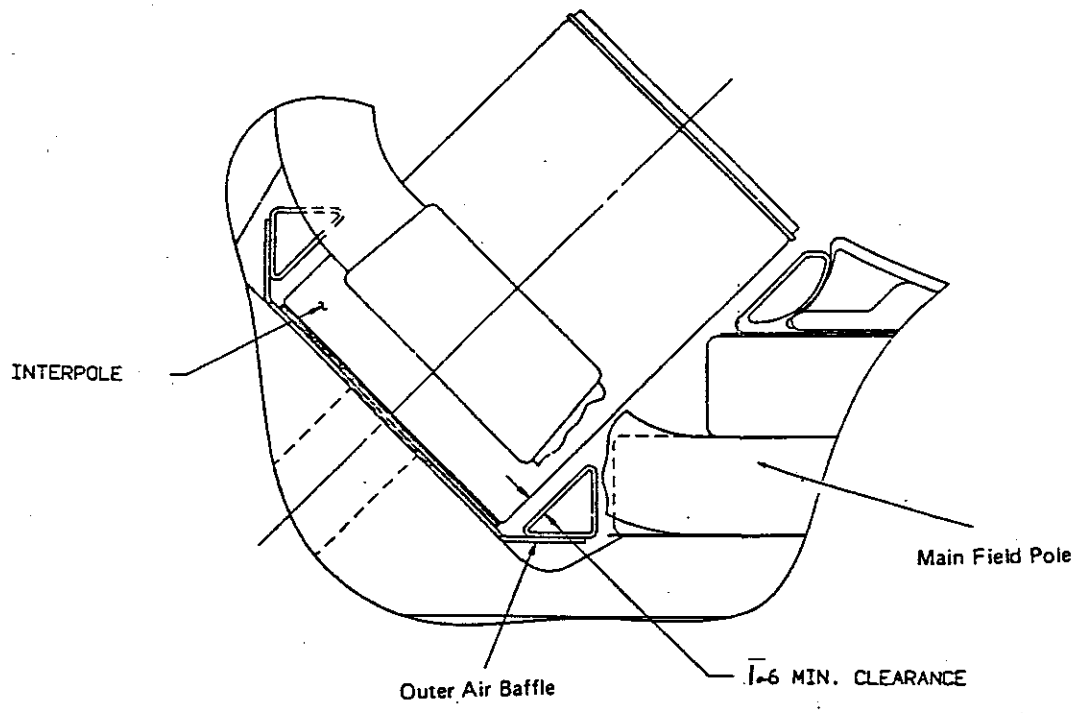

Fig. 11 - Silicone Rubber Pad Application to Outer Air Baffle

7. When all coils are tested and found good cold, the test should be repeated with the coils hot. Heat the field coils by rapidly passing current through the coils. The current can range from 1100 to 1200 amperes DC for a sufficient time to produce a temperature rise in the coils of from 130° C to 140° C. The temperature rise can be calculated using the following equation:

$$T_{rise} = \frac{\frac{Voltage}{Current}}{R_{cold}} \times (234.5 + T_{cold}) - 234.5 - T_{ambient}$$

T is temperature in °C, and R is resistance from the Kelvin bridge.

8. When required temperature is obtained, repeat Steps 2 through 6.

HIGH POTENTIAL TEST

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

When all necessary repairs are completed to the stator coils circuits, or if no repairs were necessary, apply a 3200 volt high potential test to the stator at room temperature for 1 minute at ambient temperature.

STATOR OVER HAUL

COIL REMOVAL

When it is necessary to remove the stator coils, it is advisable to place the stator in a fixture, similar to Fig. 12, 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.

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.

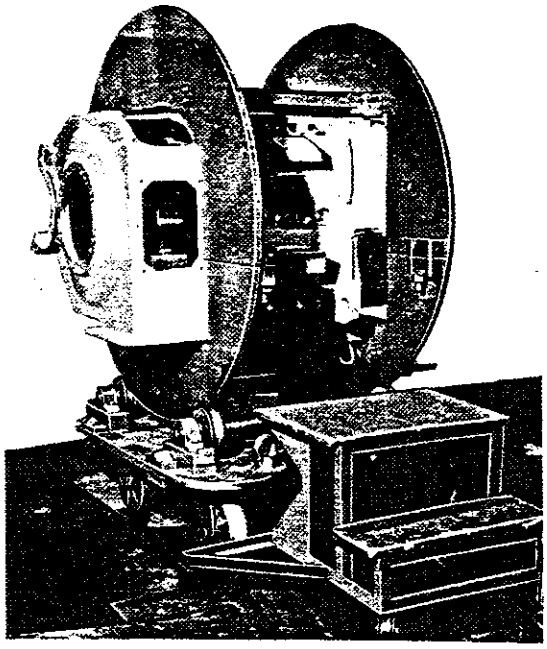

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Fig. 12 - Stator Holding Fixture

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.

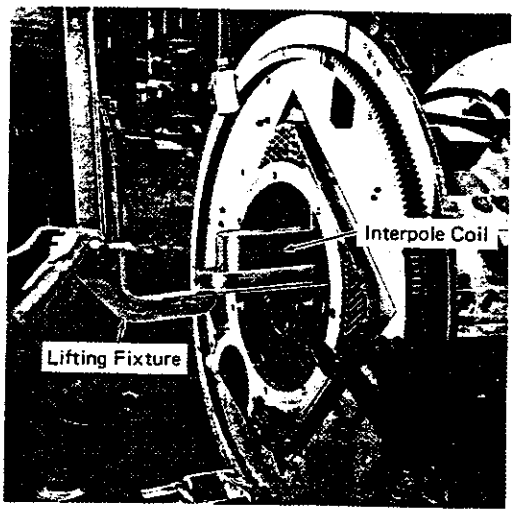

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Fig. 13 - Interpole Coil Removal

5. Using lifting fixture and a hoist, position the fixture under and up against the interpole coil to be removed as shown in Fig. 13. Refer to Service Data for fixture part number. Remove the bolts holding the coil to the stator frame.

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 The main pole pads dimension should be from 605.59 mm to 605.99 mm 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.

NOTE: If only one or two adjacent coils are removed from the frame, check the dimension from the pole seat to the opposite pole face. Subtract 63.88 mm from this dimension which will be maximum air gap acceptable with a minimum clamp of 0.38 mm, After installation of shimmed coil, the air gap must be less than the computed dimension.

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

When replacing coils ensure 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 coils to the frame. The axle cap or simulator should remain in position during assembly until armature has been assembled into stator. Refer to Service Data for simulator file number.

All coil studs are to be lubricated with a suitable thread lubricant.

INSTALLING MAIN FIELD COILS

The coil locations have been numbered as to position in the stator frame. Refer to Fig. 14. 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 lineup gauge. The No. 4 coil then becomes the reference point when spacing other coils.

Install the main field coils as follows. Refer to Fig. 14.

NOTE: Main field coil studs are to be lubricated with a suitable thread lubricant.

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.

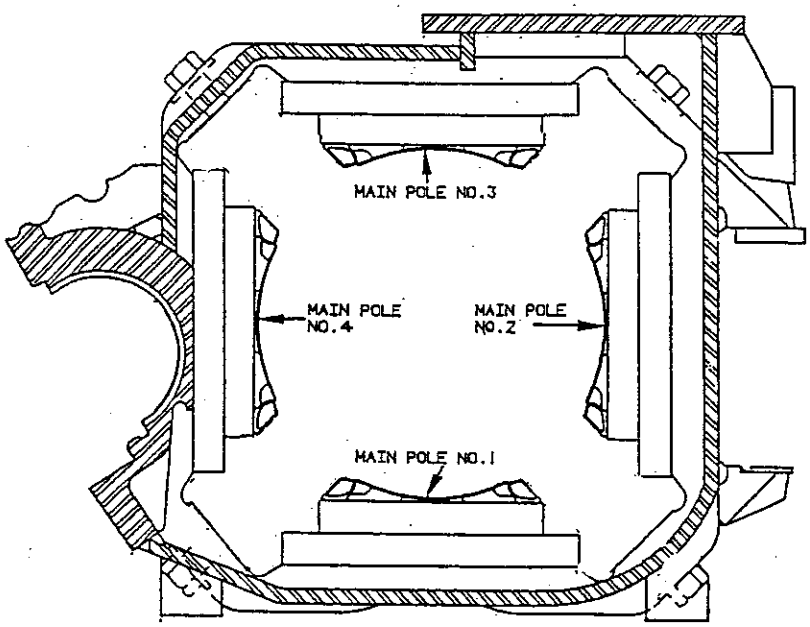

Fig. 14 - Main Field Coil Locations from Pinion End

2. Position the frame so that an interpole pad is located at the bottom. Using outer air baffle positioning fixture, place the locating knobs on the bottom of the fixture into the interpole bolt holes and tighten the two top hand screws. Position the fixture in the frame so the end locking screw handle is facing the commutator end.

3. Place one outer air baffle on either side of positioning fixture into the location provided, Fig. 15. 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.

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

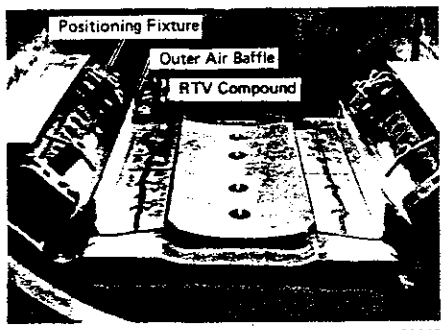

Fig. 15 - Outer Air Baffle Positioning Fixtures

5. Apply a bead of RTV compound, 6 mm (1/4") in diameter and 356 mm (14") long on the coil side of the outer air baffle, Fig. 15. The RTV should be centred across the four 25 mm (1") diameter baffle holes. This application will require approximately 85 g (3 oz) per stator. 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.

6. 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. 16.

7. 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. 17. Align studs of coil assembly with holes in stator frame and raise coil assembly. Apply nuts and lockwasher to pole studs. Tighten nuts starting from the commutator end stud. Remove lifting fixture.

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

9. Repeat operation for No. 3 and No. 4 main field coils, using lineup pins for No. 4 coil assembly.

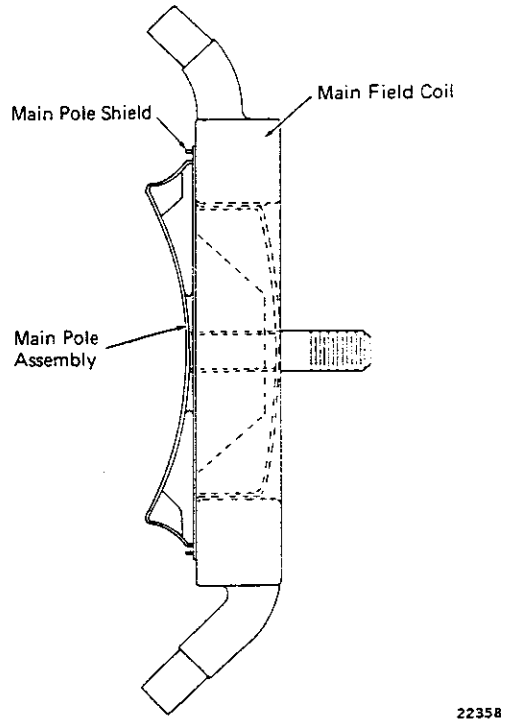

Fig. 16 - Main Coil Position on Pole and Shield

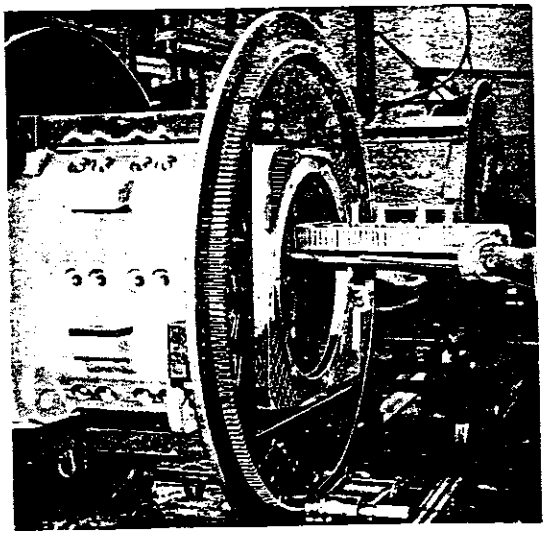

Fig. 17 - Main Coil Being Placed into

When No. 4 coil assembly is in position, remove the two lineup pins and install bolts. Tighten No. 1 and No. 4 bolts to hold coil in stator frame. Bolts will be properly tightened when No. 4 coil is aligned.

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 lineup 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. 18. 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.

Fig. 18 - Aligning Fixture in Position

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 lineup gauge. Shift coil as necessary by using the adjusting screws.

4. When the coil is properly aligned to the fixture, rotate the No. 4 coil to the top position and tighten bolts. Remove adjusting screws and check alignment of coil.

5. Rotate stator fixture 90^{o} and torque the bolts. Tighten bolts in the following manner. Starting with the commutator end bolt, tighten bolts to 813 to 949 N-m (600 to 700 ft-lbs) in several passes. Loosen bolts to below 407 N-m (300 ft-lbs) and retorque to 407 to 441 N-m (300 to 325 ft-lbs).

6. Recheck alignment of the No. 4 main field coil, and if still satisfactory, rotate coil to bottom position and remove lineup 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. 19. Refer to Service Data for gauge and jack part number.

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").

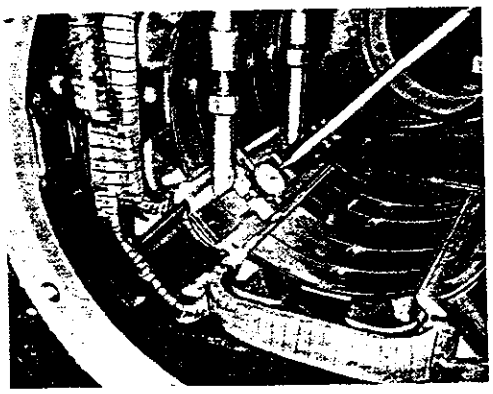

Fig. 19 - Spacing Main Field Coil

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 1.6 mm (1/16") minimum inner air baffle clearance between main field coil and baffle.

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

5. Tighten bolts of the 1, 2, and 3 main field coil in the following manner. Starting with the commutator end bolt of each coil, tighten all of each coil to 813 to 949 Nm (600 to 700 ft-lbs) in several passes.

6. Recheck spacing. If satisfactory, check air gap between opposite main field coils with gauge. Refer to Service Data for gauge part number.

   Measure the gap at the pinion end and commutator end between the pole studs, A of Fig. 4, dimensions should be as follows:

Between Studs (A) : 157.99mm Min
159.51mm Max.

7. Check out-of-round condition of the pinion end and commutator end bores. Ensure pinion end axle cap or simulator is installed. The maximum out-of-round limits are 0.3 8 mm (.015") at the pinion end and 0.13 mm (.005") at the commutator end.

8. Tack weld No. 4 main field coil bolts. This tack weld is necessary because no lockwashers are used with the bolts of the No. 4 coil assembly.

HIGH POTENTIAL TEST

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

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 MAINTAIN FIELD COIL CONNECTIONS

1. Index stator frame fixture so that No. 3 main field coil is in the bottom position. Position "F" lead assembly through cable grommet and locate 38 mm (1-1/2") flat surface of terminal lug of "F" lead against bare copper to top lead of No. 3 coil as shown in Fig. 20, Section B-B. Position leads to ensure maximum surface contact.

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

3. Position brazing equipment over surface to be brazed and clamp the joint together. Wrap heat protection around coil and lead insulation to protect insulation from heat.

4. Actuate the 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 a filler.

5. When braze is completed, wait until solder has definitely solidified and then remove brazing equipment. Remove heat protection, brush joint clean.

6. Index frame fixture to position No. 4 coil, install and lineup "FF" lead to the No. 4 main field coil and perform brazing operation as instructed for "F " lead. See Fig. 20, Section A-A, for "FF" lead position to No. 4 coil.

7. Index frame fixture so that the location where the lead ends of the No. 1 and No. 4 main field coil overlap is at the bottom position. Align bottom lead of No. 4 main field coil and bottom lead of No. 1 main field coil so that lead ends are parallel and as close as possible with an overlap of 25 mm. Be sure leads are clear of the frame.

8. Apply flux to surfaces to be brazed. Insert silver brazing pieces between leads and position equipment and braze connection as previously instructed. When brazing alloy has solidified, remove brazing equipment.

9. Index stator frame fixture so leads between No. 1 and No. 2 main field coils are at the bottom. Align top lead of No. 1 main field coil to top lead of No. 2 main coil so that lead ends are as close as possible with an overlap of 25 mm. Braze connection as previously instructed.

10. Index frame fixture so leads between No. 2 and No. 3 main field coils are at the bottom. Align bottom lead of No. 2 coil and bottom lead of No. 3 coil so that lead ends are as close as possible with an overlap of 25 mm. Braze connection as previously instructed.

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. 21.

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.

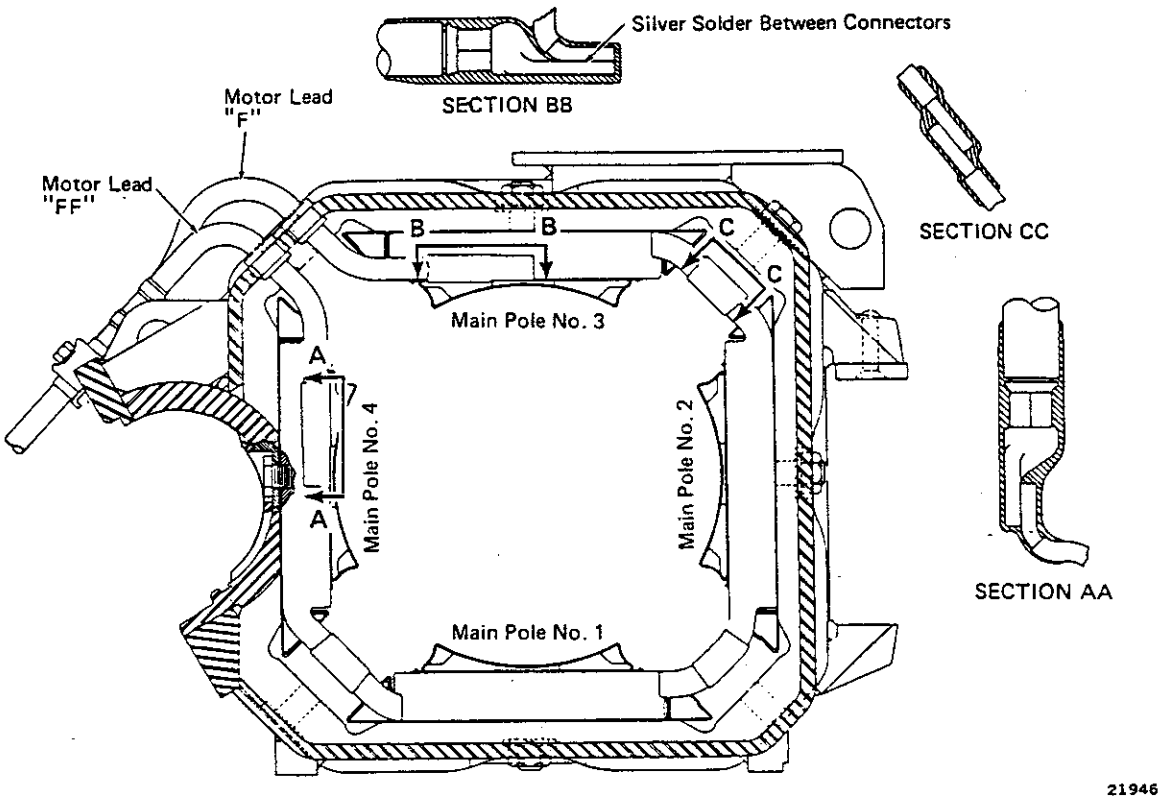

Fig. 20 - Main Field Coil Connections

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 older models). This number or vertical paint marks indicate the number of 0.584 mm metal shims required with the interpole coil. These shims are required to maintain a tight coil. Add only the amount specified, making certain that all shims are aligned centrally on the coil and do not overlap onto pole piece. Refer to Fig. 22.

NOTE: If the shims are permitted to get between the pole piece and the frame, the air gap between opposite interpoles will be too small.

4. Install two temporary aligning studs into pole piece holes 1 and 4. Insert coil assembly into stator frame through the pinion end housing bore. Align studs to frame and raise coil within approximately 6 mm of pole pad frame.

5. Ensure shims are properly aligned on top of coil. Position inner air baffle centrally with respect to projections of the interpole washer.

NOTE: Interpole coil bolts are to be lubricated with a suitable thread lubricant.

6. Insert coil bolts and washers into pole bolt holes 2 and 3 and tighten. Ensure inner air baffles are not distorted when bolts are tightened.

7. Remove lifting fixture from stator frame and remove temporary aligning studs from interpole coil holes 1 and 4. Install interpole bolts.

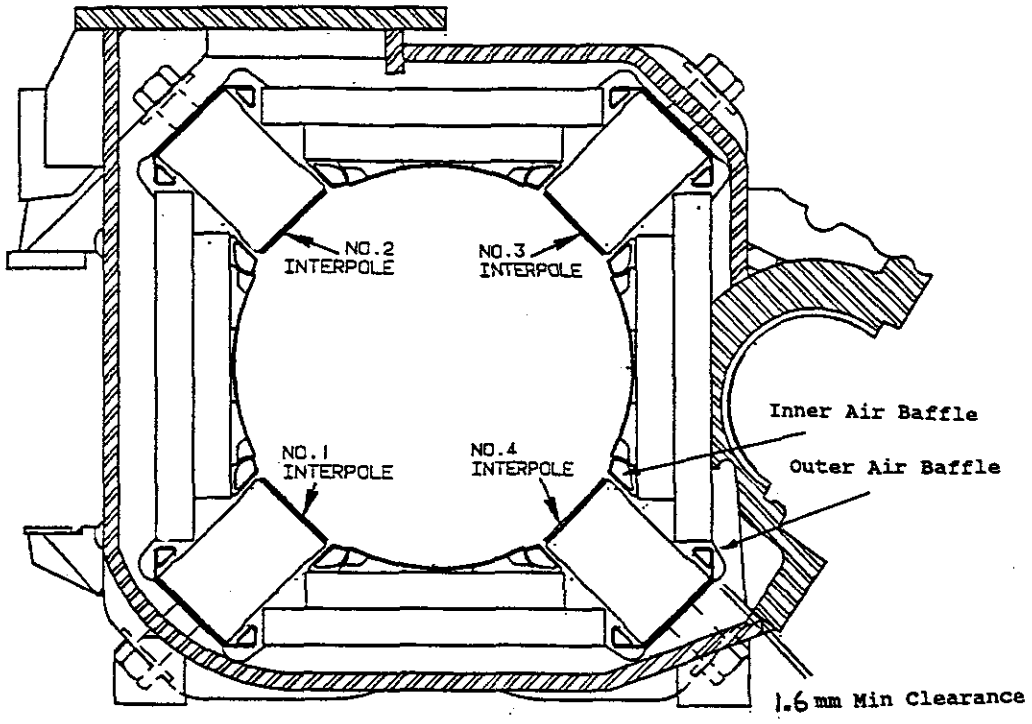

Fig. 21 - Interpole Coil Positions from Commutator End

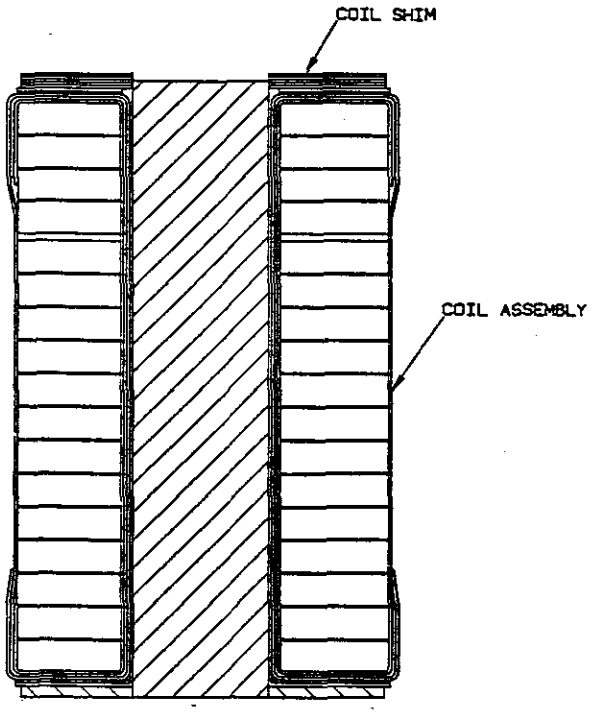

Fig. 22 - Interpole and Coil Assembly Cross-Section

8. Index stator frame fixture as necessary to install the three remaining interpole coils. Ensure coil leads face the commutator end of the stator frame.

SPACING INTERPOLES

1. Use interpole jack as required to obtain a maximum allowable variation of 0.76 mm between all poles. Take measurements approximately 63.5 mm from both end pieces of adjacent main field pole pieces. Loosen three bolts of interpole coil and move coil assembly to desired position.

NOTE: Do not disturb main field coils when spacing interpoles.

2. When interpoles are properly spaced, check the space between the interpole coils and baffles, Fig. 21. Minimum allowable clearance is 1.6 mm.

3. Check air gap between opposite interpole coils with a gauge. Refer to Service Data for gauge part number. Measure pole at each end approximately 76 mm in from end of pole. The distance between opposite interpoles should be 481.23 mm ± 0.25.

HIGH POTENTIAL TEST

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

1. Make temporary connections between interpole coils with battery clips or similar clamps. Connect the bottom coil leads of 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. 2 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

Stator interpole coils are connected by cable assemblies and the older models are connected by coil connector assemblies. The following procedure can be used for both configurations unless specifically identified.

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

2. Position either one long cable assembly or one long coil connector assembly between the stator frame side leads of the No. 1 and No. 2 interpole coil so that the terminal lug of the cable or 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. 25. Temporarily clamp the other end of the cable or 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. Place heat protection around lead and connector insulation and 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. Remove heat protection and 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.

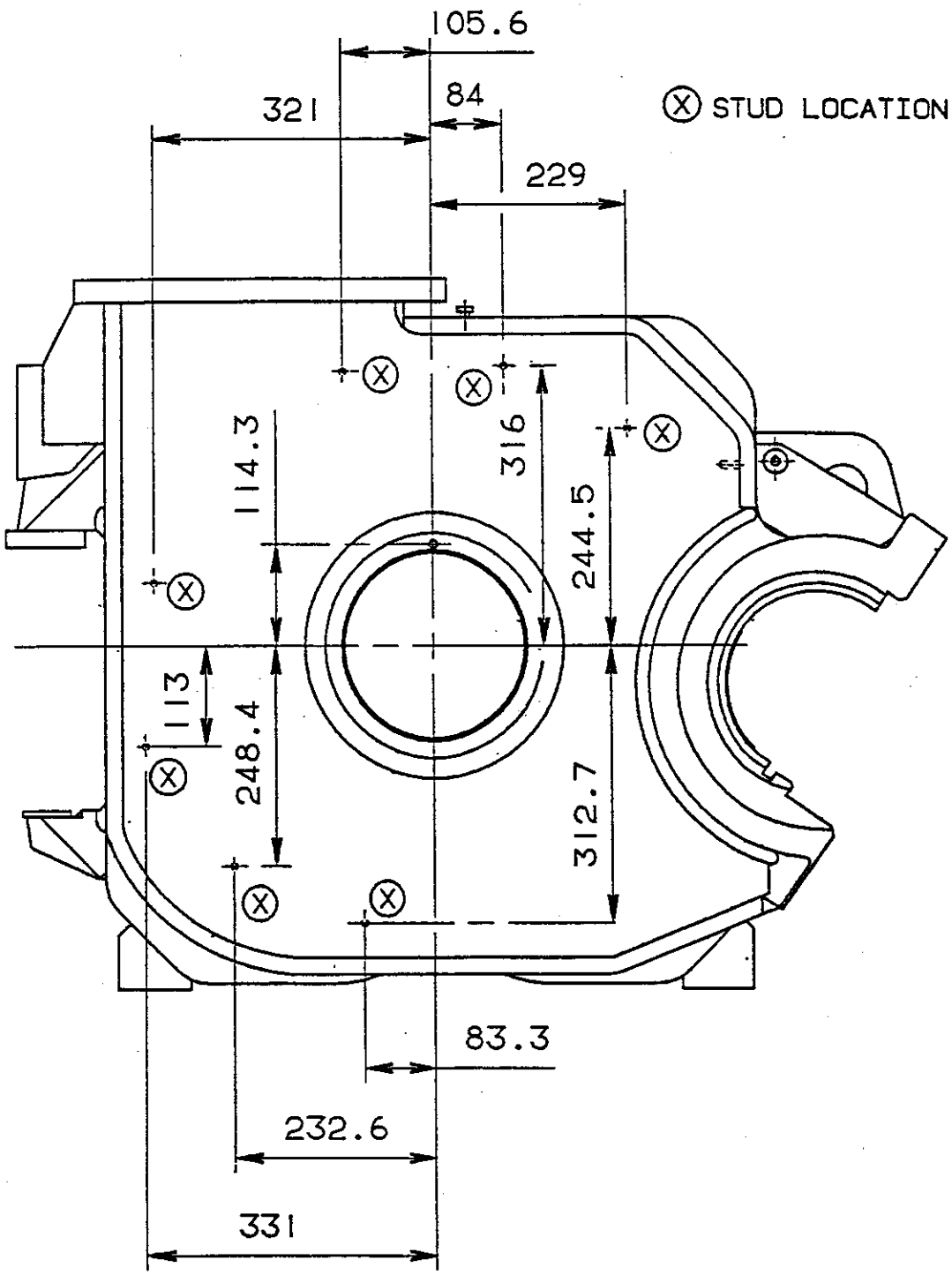

Fig. 23 - Brush Holder Cable Clamp Stud Location

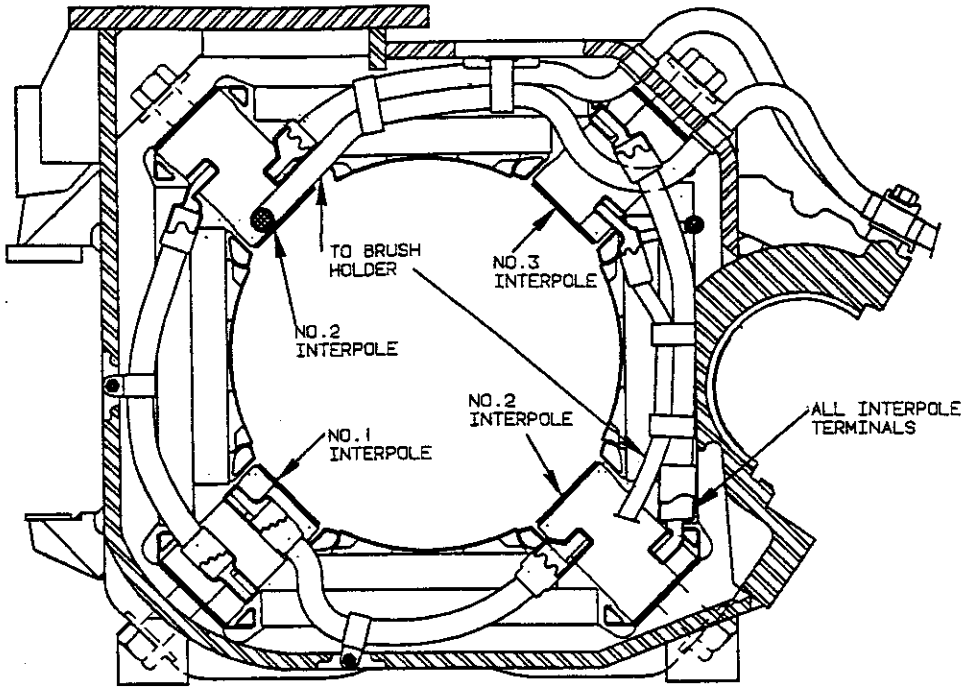

Fig. 24 - Interpole and Brush Holder Cabling

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

9. While stator frame is in this position, install a short cable assembly or a short coil connector assembly between the No. 1 and the No. 4 interpole coils. Place the terminal lug of the cable or 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 cable assembly or the short bent end of the coil connector on the armature side lead of the No. 4 interpole coil as shown in Fig. 25. Temporarily clamp the other end of the cable or 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 cable assembly or a long coil connector between the frame side leads of the No. 4 and No. 3 interpole coil and place this cable or connector on the frame side of the leads. Position stator frame as necessary and braze connections.

12. Locate the remaining interpole coil connecting cables or connectors at each interpole coil and braze connections.

INSULATING MAIN FIELD AND INTERPOLE CONNECTIONS

Insulate all brazed 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, tape over joint, and finish one tape width beyond joint.

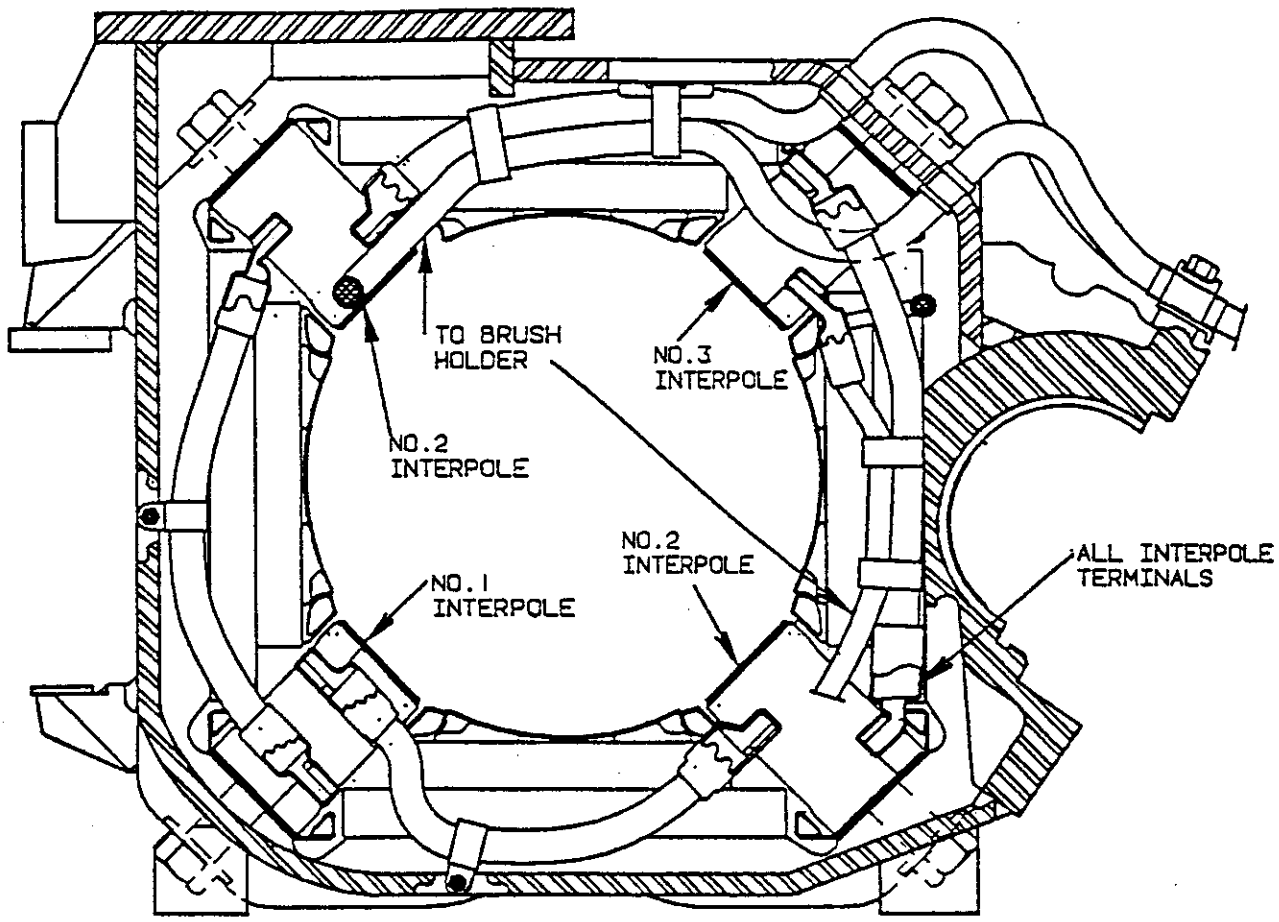

Fig. 25 - Coil Position and Connection from Commutator End

Tape overall with one layer half lapped of pressure sensitive glass 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.

2. Insulate all connections between interpole coils and all connector terminations to interpole coils with two layers of silicone rubber tape half lapped. Start taping two tape widths before the joint, tape over joint, and finish two tape widths beyond joint. Tape overall with one layer half lapped of pressure sensitive glass tape. Start and finish glass tape one half the tape width beyond the silicone rubber tape.

3. If insulation at lead areas of field or interpole coils is cracked or damaged during lead alignment for brazing, repair cracks or damage with RTV compound. Refer to Service Data for RTV compound part number.

using, used formed cables, install motor brush holders.

2. Connect brush holder cables using insulated clamps, flat washers and self-locking nuts, or insulation pieces and torpedo twine as shown in Fig. 26.

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

   e. Remove masking

2. 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 apart, approximately half way between grommets and cable cleat as shown in Fig. 27. Tighten and cut steel strap with a steel binder set. Lock strap with the strap seal and remove steel binder set.

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

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

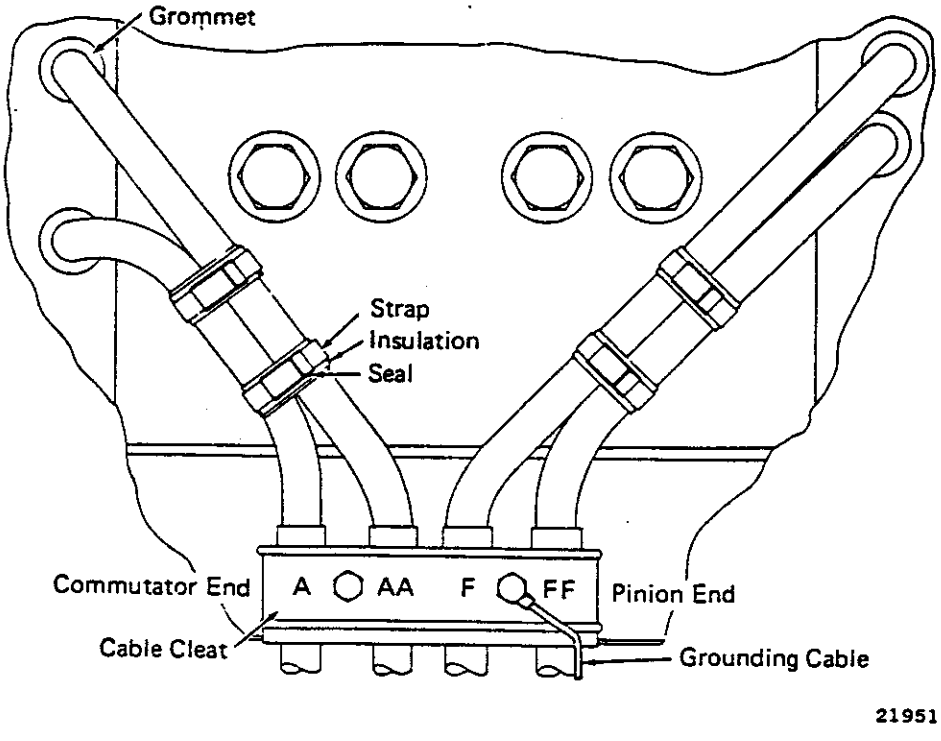

Fig. 27 - Exterior Cable Lead Arrangement

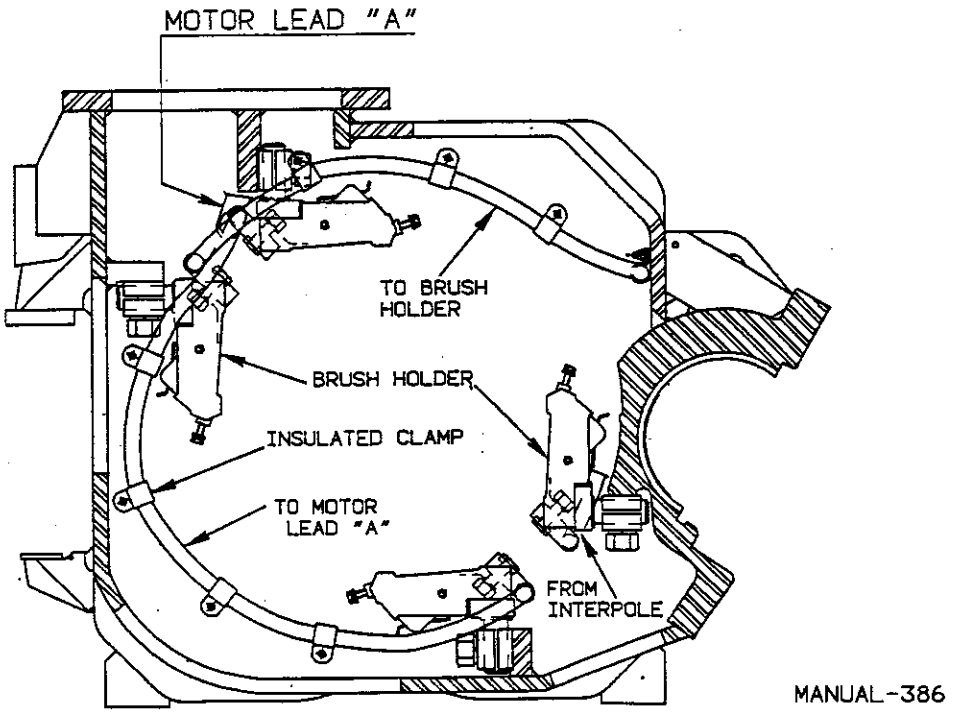

Fig. 26 - Securing Brush Holder Cross Connection

SECURING COMMUTATOR END LEADS, JUMPERS, AND CROSS CONNECTORS

1. Wrap the "A" and "AA" leads with webbing and secure to "saddle" on the upper side of the frame with steel strap as shown in Section A-A of Fig. 24 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 glass adhesive tape. Refer to Service Data for webbing, steel binder set, and tape part numbers.

2. Wrap the "A" and "AA" leads between the "saddle" and interpole No. 2 with webbing and secure together with steel strap and seal as shown in Fig. 24. Tighten steel strap, cut and insulate in the same manner as Step 1.

3. Wrap the brush holder lead and interpole coil jumper between interpole No. 3 and interpole No. 4 with webbing and secure the lead to the jumper with a steel strap in two places. Tighten steel strap and insulate in the same manner as Step 1. Dress the cable toward the axle side of the frame along the interpole coil jumper to provide proper clearance from the armature commutator riser.

4. Fasten the interpole coil jumpers between the No. 4 and the No. 1 interpole and the No. 1 and the No. 2 interpole to the frame with insulated clamps. Secure the clamps with flat washers and self-locking nuts.

5. Fasten brush holder cables to frame with insulated clamps. Secure the clamps with flat washers and self-locking nuts as shown in Fig. 26.

BRUSH HOLDER CONNECTIONS

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

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.