ELECTRO-MOTIVE

M.I. 3952-6
*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 6
ARMATURE OVERHAUL

INTRODUCTION

When inspection of the armature indicates the armature must be rewound, the coils must be removed and the commutator and core prepared prior to rewinding.

The purpose of this section of the Maintenance Instruction is to guide personnel engaged in performing these operations to ensure satisfactory performance in operation.

ARMATURE COIL REMOVAL

1. Apply armature shaft (lathe) driving wedge to the threads at the pinion end of the armature. Refer to Service Data for driving wedge part number.
2. Place armature assembly (with driving wedge attached) in a lathe. The lathe must be equipped with a face plate which will attach to the driving wedge. The lathe must also have a "live center" in the tail stock to prevent possible damage to the armature shaft center.
3. Install armature coil cutting tool in the lathe tool holder and rotate the armature at approximately 76 RPM. Refer to Service Data for armature coil cutting tool part number.
4. Cut the coils at two points as shown in Fig. 1.
   a. At commutator end, behind the commutator, between the riser and the fiberglass band. Do not damage commutator.

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

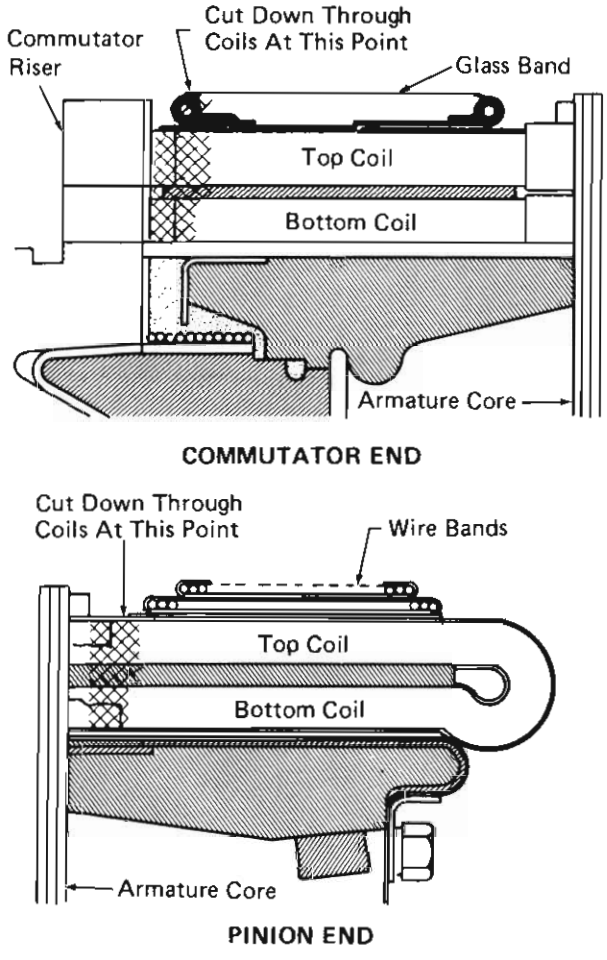

Fig. 1 – Cutting Armature Coils

b. At pinion end, between the armature core and the wire band. Do not damage core.

NOTE: Cut the top layer of coils so that the cut area will be wider than the cut area for the lower coils. The top clearance will prevent tool jamming when cutting the bottom coils.

5. Remove armature from lathe. Remove armature shaft driving wedge and place armature in a suitable stand. The stand should hold the armature securely and permit the armature to be rotated.

WARNING: In Step 6, use care when cutting the armature bands. The bands are applied under tension and injury could result to the operator as the bands are released during cutting.

6. Remove the bands from the armature by using a sharp chisel and hammer. Cut through one layer of bands at a time as shown in Fig. 2. Newer assemblies will be equipped with glass bands at the commutator end instead of wire.

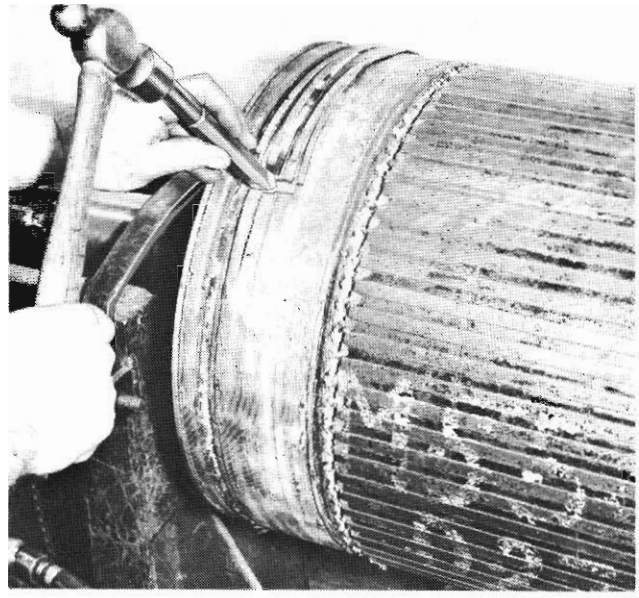

Fig. 2 – Removing Wire Bands

7. Separate and remove the section of coils at the pinion end which had been under the wire band.

8. Raise the coil ends between the core and commutator. Raise one layer at a time. Fig. 3 shows a method of removing the coils without first removing the armature slot wedges. Ensure the coil being removed is a top coil and that the coil is being pulled up straight to prevent binding or damaging the end plates of the armature core.

Fig. 3 – Removing Armature Coils

9. Clean core and coil supports thoroughly. Remove all pieces of insulation, dirt, cement, carbon dust, and any other foreign material. Do not use heating torches or sand blasting for this operation which could damage the armature core. Smooth cut files and scrapers can be used carefully so as not to damage the laminations.

ARMATURE INSPECTION AND CLEANING BEFORE REWIND

1. Remove all burrs and nicks from armature core slots, end plates, and coil supports. Any nick or burr could damage coil insulation.

2. Check all slots to ensure that core laminations in slots are aligned and not bumped out-of-line. Check slots for alignment with slot gauge, Fig. 4. The gauge is to fit slot with a slight "feel" and should be neither loose nor tight. If laminations have been bent, they may be realigned by inserting a wedge, the same size as the gauge, and tapping lightly with a mallet. Use care so as not to roughen or burr laminations. If core slots are tight, file the core slots with a slot file as shown in Fig. 4. Do not file the core slots excessively to cause shiny spots. Excessive filing will cause drag-over of laminations which will result in shorting between the laminations causing core heating (hot spots) during operation. Refer to Service Data for gauge and file part numbers.

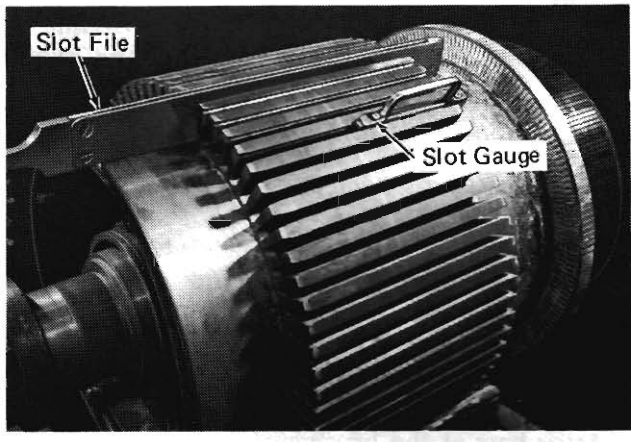

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Fig. 4 – Checking And Filing Core Slots

3. Check all slot wedge grooves with wedge slot gauge, Fig. 5. The gauge is to fit slot wedge groove with a slight "feel" and should be neither loose nor tight. If gauge will not fit properly, use wedge slot file to clean out slot as shown in Fig. 5. Refer to Service Data for gauge and file part numbers.

NOTE: Preserve the upper portion of the slot wedge groove which is the slot wedge contact surface. Excessive filing will distort the wedge slot.

4. Check the core end plates at both ends of the slots with a gauge, Fig. 6. Ensure there is clearance at both sides of the end plate for the "U" piece insulation which will be applied when winding the armature.

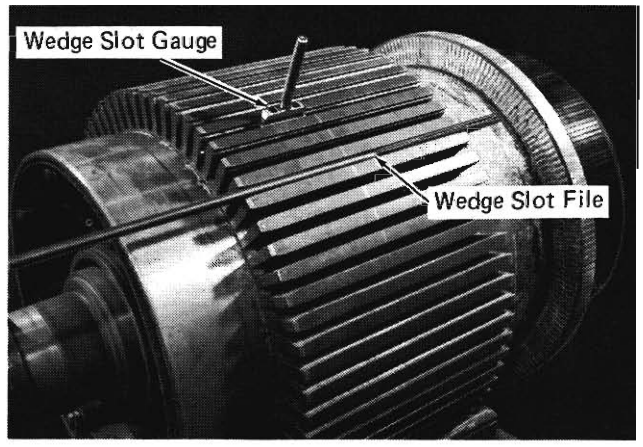

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Fig. 5 – Filing Wedge Slot

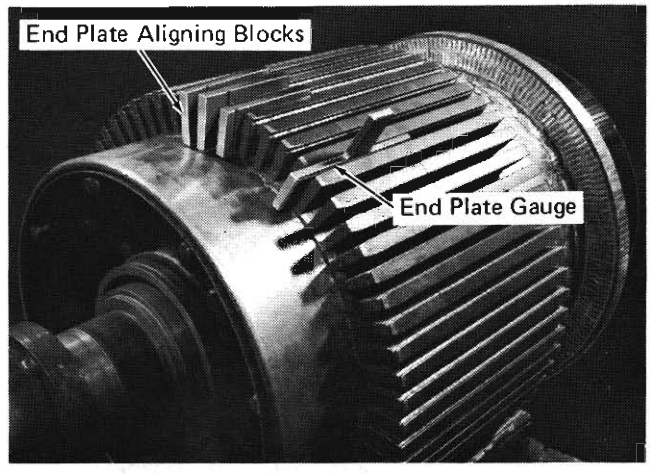

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Fig. 6 – Checking End Plate

NOTE: Do not use the gauge to line up the end plates. Use a wedge, Fig. 6, made to the size of the gauge, which can be tapped. Aligning end plates with the gauge can damage the gauge.

5. Inspect the end plates for breaks or separations. If they are separated, push back in place and file a small "V" notch in the top of the end plate. Weld the end plate in place and file to shape.

6. Clean commutator end and pinion end coil supports thoroughly of all insulation, varnish, and shellac.

7. Inspect commutator end and pinion end coil supports for cracks. Replace coil support with a new coil support if cracked. No welding should be performed on coil supports. Refer to the following paragraphs for coil support replacement.

REMOVING COMMUTATOR RISER COIL LEAD ENDS

There are two methods for removing the coil lead ends from the commutator riser. The recommended method is by using induction heating to melt the solder. If induction heating is not available, the coil leads can be removed from the riser, using hand tools. Perform one of the two following procedures:

LEAD REMOVAL WITH INDUCTION HEATING

1. Using an induction heating machine with a heating coil, Fig. 7, heat a section of the commutator riser to a point where the solder just starts to melt. As the solder starts to melt, rotate that section of the commutator riser out of the heating coil.

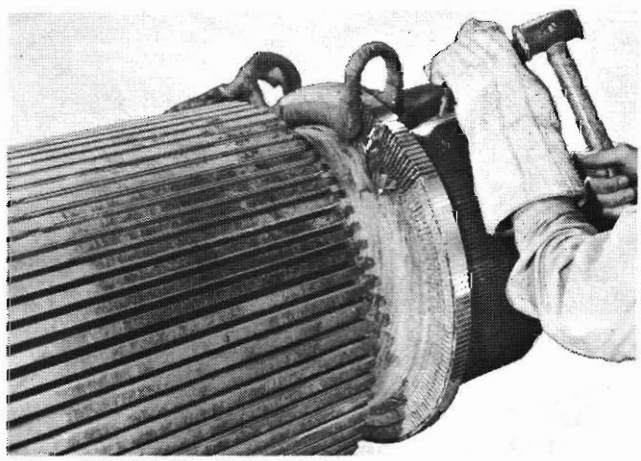

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Fig. 7 – Heating Riser For Lead Removal

2. Knock out the coil lead ends from the riser with a chisel as the riser moves out of the heating coil as shown in Fig. 7. Refer to Service Data for chisel part number.

COLD LEAD REMOVAL

1. Split both sides of the coil lead ends at the riser with a chisel by carefully driving the chisel down between the commutator riser and the lead ends. Do not damage the riser.

2. Knock the coil lead ends out of the riser with a chisel as shown in Fig. 8. Use care to prevent damage or distortion to the riser.

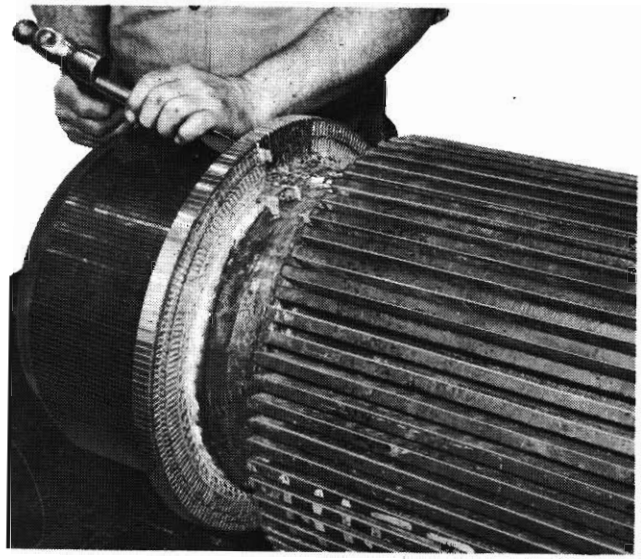

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Fig. 8 – Cold Lead Removal

COMMUTATOR RISER CLEANING AND INSPECTION

1. When all the coil lead ends have been removed from the commutator riser slots, the bottom and sides of the slots should be scraped to remove all excess solder and oxidation. Remove any solder, carbon, or dirt that may be on the back of the riser. Do not damage the mica that extends out from between the riser bars.

2. Check the riser of each bar closely for cracks. Check mica segments between riser bars to ensure the segments have not been damaged during stripping operation. Ensure all copper, solder chips, and carbon dust have been removed. Clean out slots between the commutator bars at the brush surface using a scraper. Refer to Service Data for scraper part number.

3. When the riser has been properly cleaned and excess solder removed, dip a piece of surgical tape into flux and sparingly flux all riser slots. Work flux into riser slots. Keep flux off commutator bars and mica ring behind commutator.

NOTE: If the riser cleaning cannot be completed in one operation, it is advisable to flux the cleaned area to prevent oxidation.

4. Perform commutator bar-to-bar resistance check. Refer to Section 5 of this Maintenance Instruction for procedure.

5. Ground test commutator at 5000 volts for 10 seconds prior to rewinding.

COMMUTATOR REMOVAL

If the commutator must be removed for repair or if the commutator end coil support must be removed, perform the following procedure.

NOTE: A fixture made of 51 mm (2") steel plate is required to remove the commutator. The plate must be drilled to receive four 25.4 mm (1") bolts and positioned to go into the four bolt holes of the bolts removed in Step 1.

1. Remove the four commutator bolts located on the front of the commutator spider that are indicated with an "X" on Fig. 9.

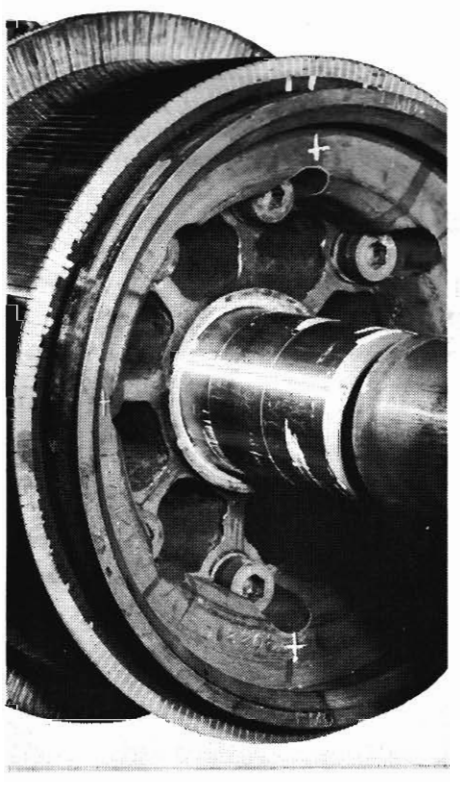

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Fig. 9 – Location Of Commutator Threads

2. Apply commutator removal fixture to front of commutator with four 25.4 mm (1") bolts into the threaded portion of the holes of the studs removed in Step 1.

3. Place pinion puller between the commutator removal fixture and the armature shaft. Check alignment to ensure the pull will be equal on all four studs.

4. Support commutator to prevent commutator from falling as it is pulled from shaft.

5. Apply pressure with the pinion puller to remove the commutator. Approximately 36 tonne (40 tons) force will be required to remove the commutator. If the ram travel is not sufficient to remove the commutator in one operation, it will be necessary to release pressure of pinion puller to allow the ram to retract and then add a steel block between the shaft and the ram. Repeat operation until the commutator is removed.

SHAFT AND COMMUTATOR REMOVAL

When it is required to remove coil support, core laminations, or armature spider, removal of the armature shaft is required. Perform the following procedure to remove the armature shaft.

1. Remove pinion end inner oil ring if not previously removed.

2. Place the core and commutator assembly in a vertical position, commutator end up.

NOTE: Whenever it is necessary to position the armature in either a vertical or horizontal position, use a turning fixture. Refer to Service Data for turning fixture part number.

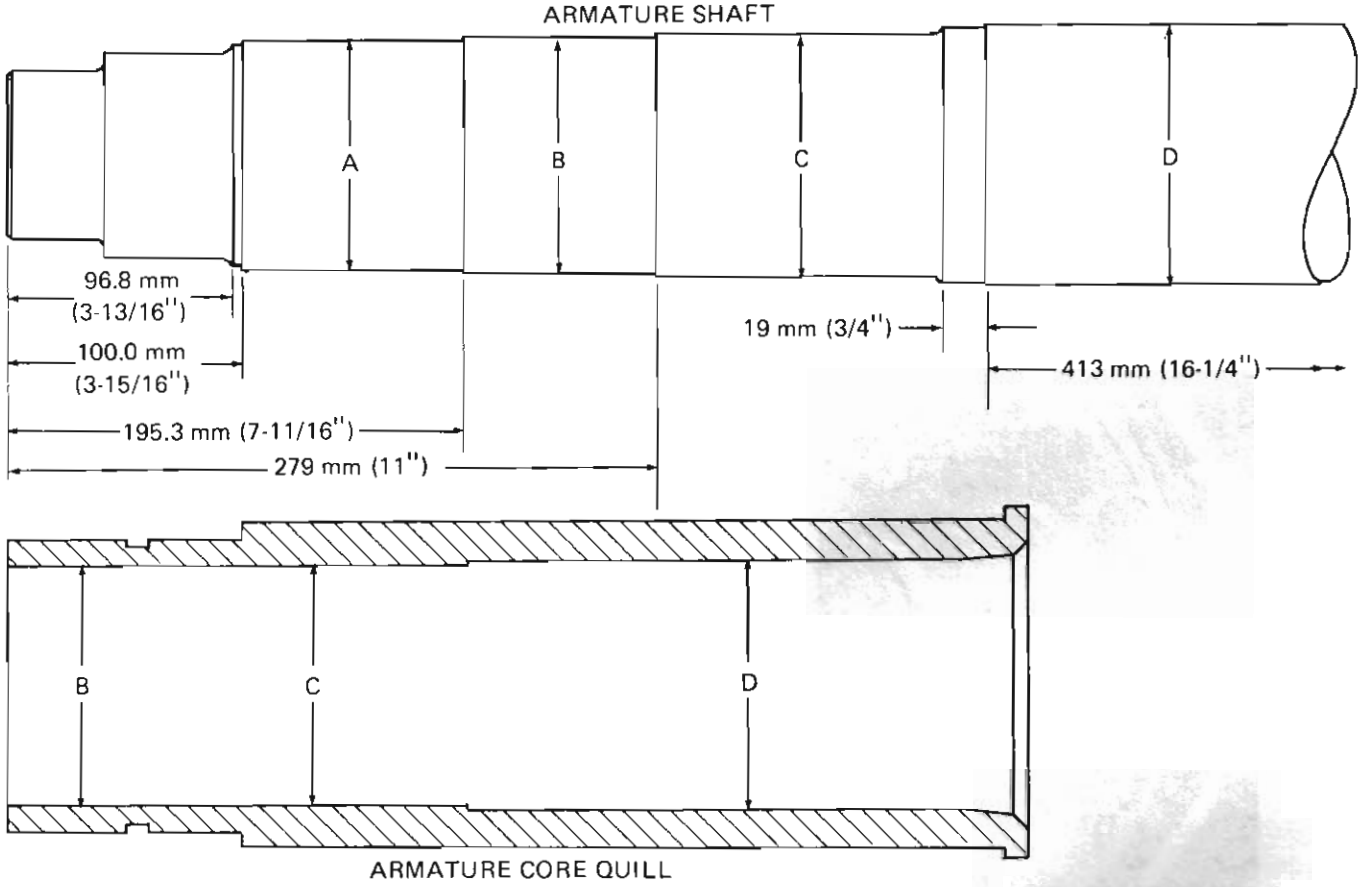
3. Place the armature assembly on a base adapter which is mounted on a pressing truck, so that the assembly is supported on the area next to the shaft at the pinion end of the assembly. Never support the assembly on the coil support when pressing shaft out.

4. Position assembly under press. Apply pressing adapter to commutator end of shaft and press shaft out. Do not allow pressure to be applied to the steel "V" ring of the commutator.

5. Commutator and core will now be free of shaft. Remove commutator and shaft from armature core.

PRESSING IN SHAFT

1. Suspend the commutator and core assembly in a vertical position, pinion end up.
2. Ensure the bores of the armature spider and diameters of the armature shaft are free of burrs and protrusions.
3. Check armature spider bores for taper and size. If bores are tapered, bores may be corrected by using an engine cylinder liner hone. Refer to Service Data for hone kit part number. If after honing, the bores are oversize, an oversize shaft must be used. Refer to Fig. 10 for interference required between the shaft diameters and the bores to maintain the proper tonnage when pressing in the shaft. Refer to Service Data for part numbers and sizes of oversize shafts available.
4. Place armature core assembly, commutator end down, on the shaft replacement base fixture on a pressing truck, Fig. 11. Refer to Service Data for fixture and pressing truck part number.
5. Apply mounting compound to the shaft as shown in Fig. 11. Ensure shaft bore is properly lined up with base adapter. Guide shaft, pinion end up, into core assembly. Place clearance gauge and pressing sleeve on pinion end of shaft, Fig. 11. Position assembly under press.



A - Shaft diameter must be 0.102 mm + 0.000, - 0.013 (.0040" + .0000, - .0005) greater than commutator spider bore diameter

B - Shaft diameter must be 0.051 mm + 0.000, - 0.013 (.0020" + .0000, - .0005) greater than quill bore diameter measured 51 mm (2") from end of quill

C - Shaft diameter must be 0.051 mm + 0.000, - 0.013 (.0020" + .0000, - .0005) greater than quill bore diameter

D - Shaft diameter must be 0.058 mm + 0.000, - 0.013 (.0023" + .0000, -.0005) greater than quill bore diameter

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Fig. 10 - Interference Fit Between Shaft And Armature Core Quill Bores

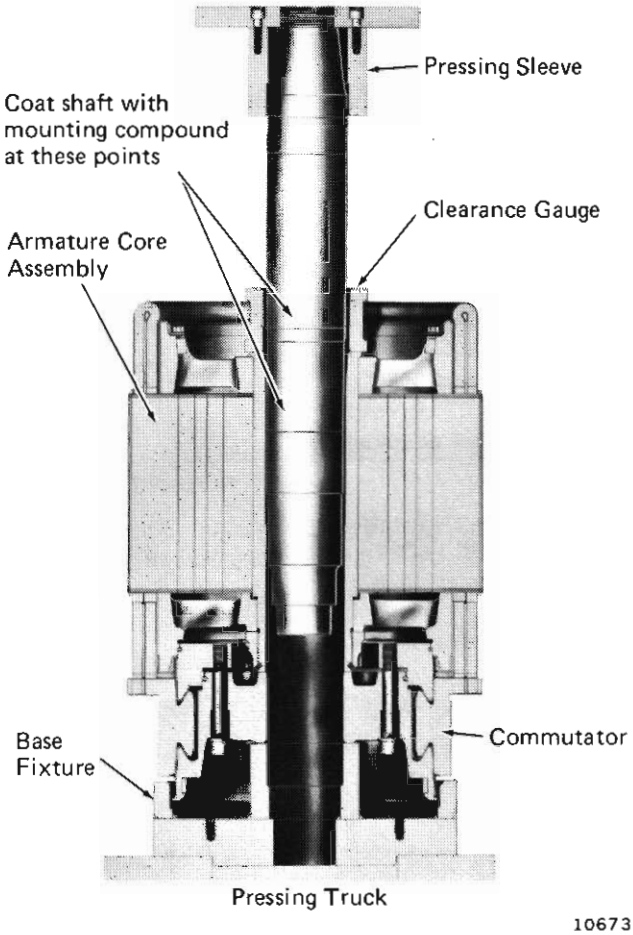

Fig. 11 – Armature Shaft In Core Assembly

6. Press shaft in slowly and observe tonnage on press pressure gauge. Pressure gauge should register between 32 and 63 tonnes (35 and 70 tons) for proper shaft to core fit. If the pressure required is less than 32 tonne (35 ton) or exceeds 63 tonnes (70 tons), remove the shaft and recheck the shaft to core fits.

7. Ensure clearance gauge is positioned between pressing sleeve and core and continue to press shaft in until pressing sleeve contacts clearance gauge. Refer to Fig. 12 for core position on shaft.

PRESSING ON COMMUTATOR

1. Clean up commutator-to-core mating surfaces. Check corresponding mating fits to ensure the fit of the average dimension is not less than 0.10 mm (.004") loose or more than 1.14 mm (.045") loose. Refer to Fig. 13. Check diameter of steel "V" ring to ensure ring is concentric within ± 0.13 mm (±.005").

2. Clean commutator-to-shaft mating surfaces. Ensure surfaces are free of all nicks and burrs.

3. Apply silicone rubber compound to groove in commutator "V" ring with a putty knife, Fig. 14. Fill groove with a sufficient amount to ensure a good seal at assembly.

4. Place core and shaft assembly in a vertical position, pinion end down, on pressing fixture. Apply a small quantity of mounting compound at beginning of commutator diameter on the shaft.

5. Mark off six equal spaced core slots for line-up positions around the outside diameter of the core.

6. Position commutator over shaft and lower into position. Line up the commutator to the core with alignment gauge bar, Fig. 15, so that a centerline of a commutator bar is approximately aligned with a centerline of a coil slot at the middle of the core. Ensure the air passages in the commutator spider line up between the spokes of the commutator end coil support. Lower the commutator as far as it will go on the shaft.

7. Move the assembly under press and press commutator down on the shaft to approximately 25 mm (1") of final position using alignment gauge bar to control temporary alignment, Fig. 16. Release pressure, remove alignment gauge bar, and remove assembly from press.

8. Set up alignment gauge and master as shown in Fig. 17. Ensure core alignment gauge is locked into core slot. Check commutator alignment as follows.

   a. Rotate cylindrical dial until the vernier on the scope holding guide is approximately at 15.88 mm (.625").

   b. Align scope hairline to right side of commutator bar on master as shown in Fig. 18.

   c. Rotate the friction barrel on cylindrical dial to zero-zero alignment.

NOTE: The cylindrical dial has numbers that indicate lateral movement of the scope in increments of 0.03 mm (.001"). Rotating this dial counterclockwise from zero is considered a "plus" reading and moves scope hairline to the left. Rotating the dial clockwise from zero is considered a "minus" reading and moves scope hairline to the right.

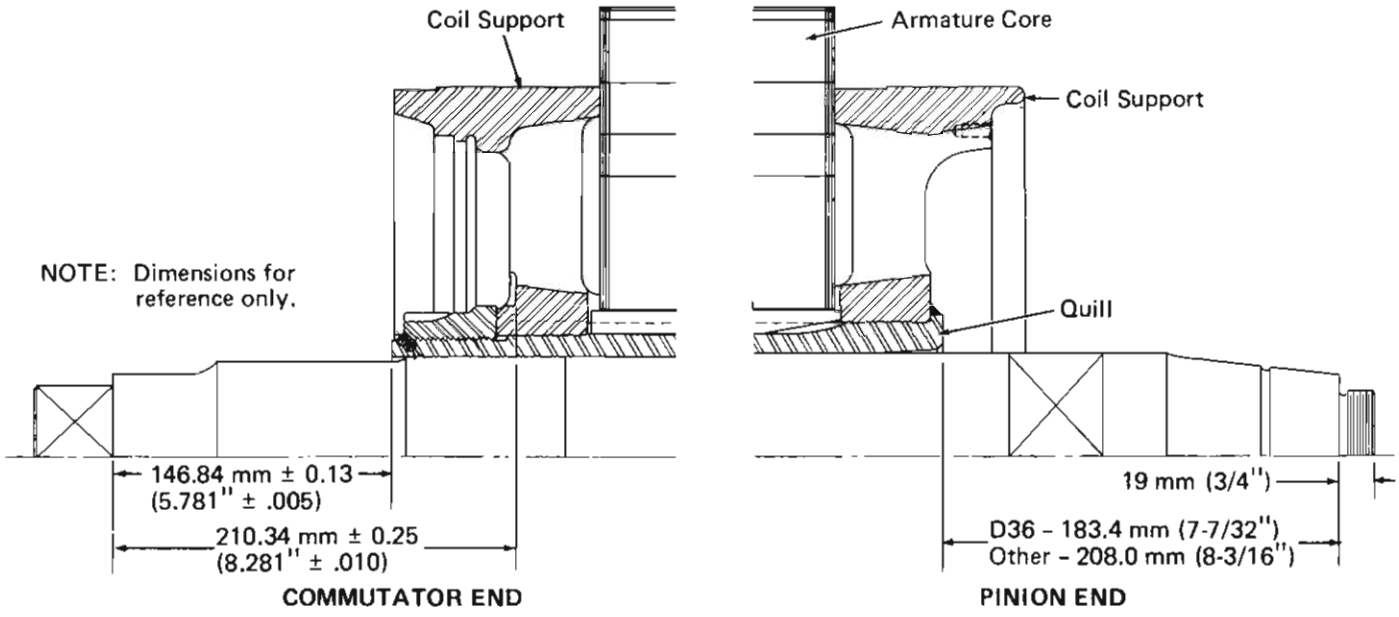

Fig. 12 - Armature Core Position On Shaft

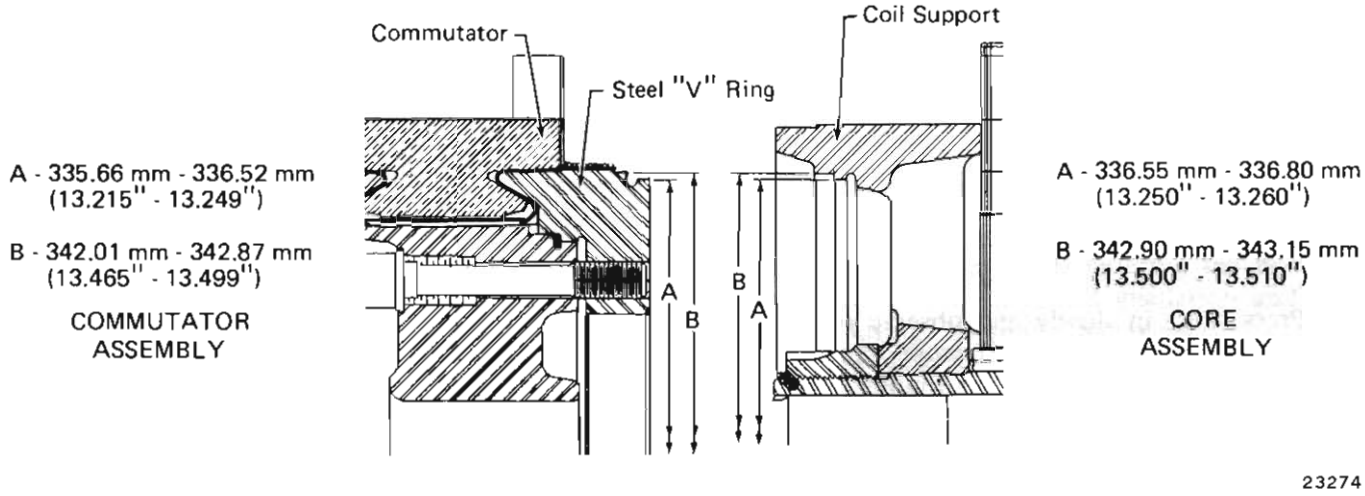

Fig. 13 - Commutator To Core Fits

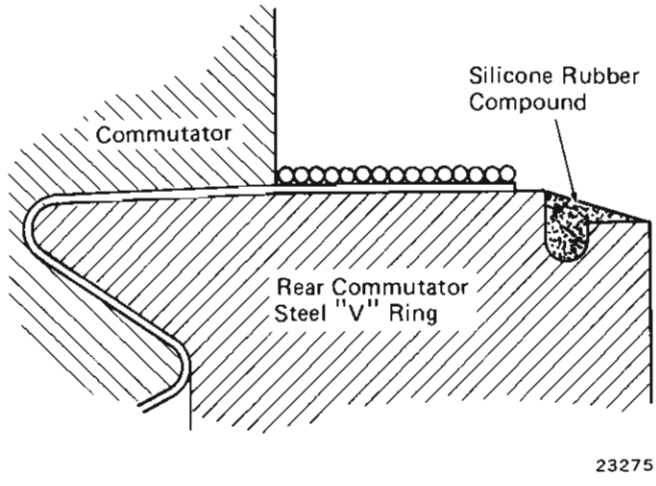

Fig. 14 - Silicone Rubber Compound Applied To Groove In Commutator "V" Ring

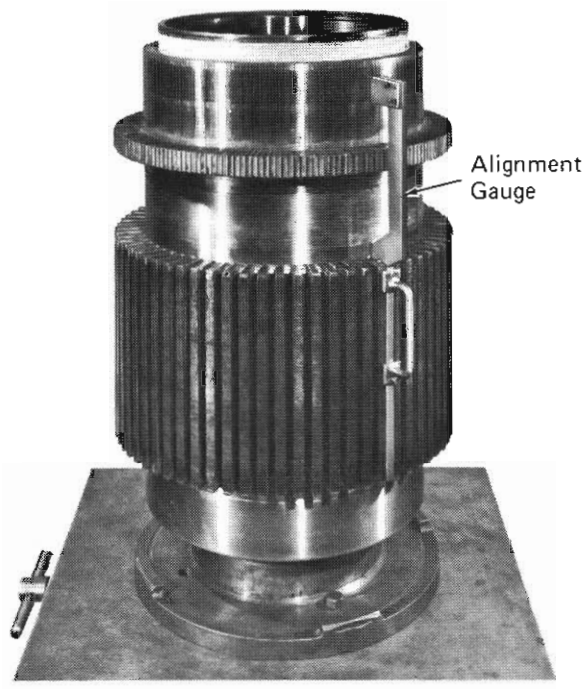

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Fig. 15 - Alignment Gauge In Position

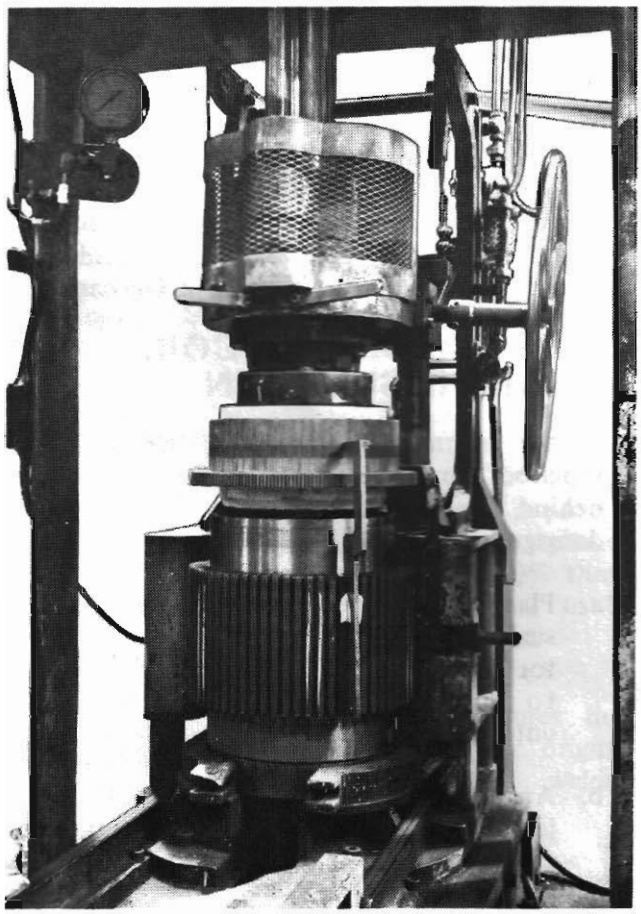

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Fig. 16 - Pressing Of Commutator To Core

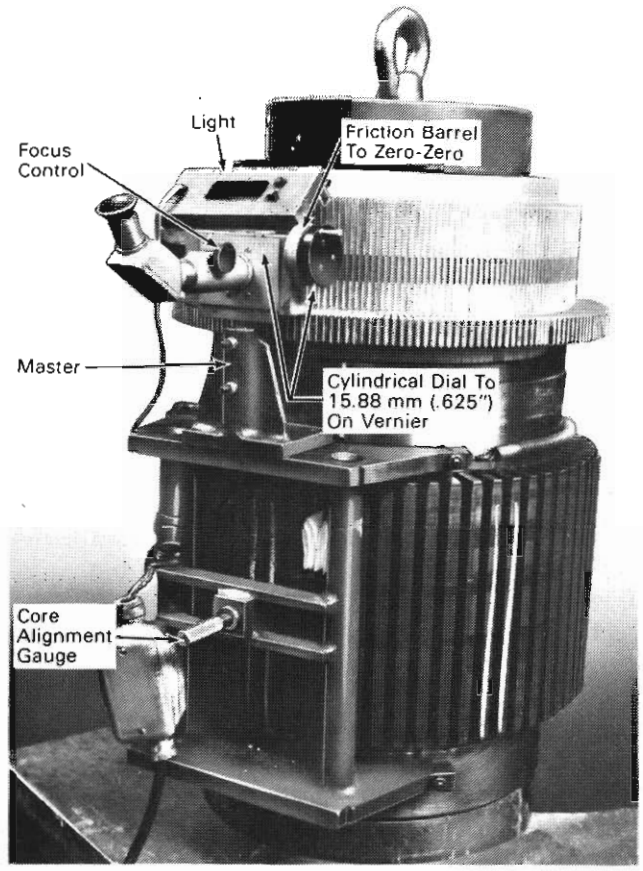

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Fig. 17 - Commutator Alignment Gauge Setup

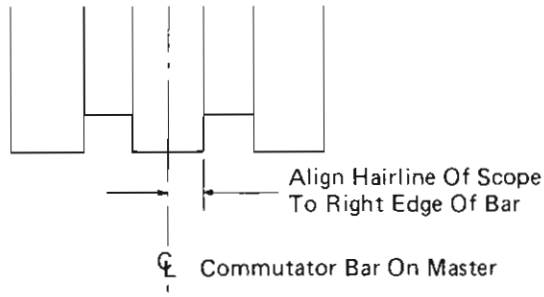

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Fig. 18 - Commutator Alignment Check

d. Position gauge on core and take six alignment readings at the slots marked on the core in previous step. Focus the scope hairline on the right hand sharp edge of the commutator bar. Read the amount in thousandths of an inch the commutator is out of line directly from the dial. Record the amount and also note whether reading is "plus" or "minus." Record these figures at all six locations. Add the "plus" readings and add the "minus" readings, and

subtract the smaller from the larger. The answer will carry the "plus" or "minus" sign of the larger figure. Divide the answer by six. This number will indicate the average amount the commutator is out of index from the core. A "minus" answer indicates the commutator is rotated too far to the right. A "plus" answer indicates indicates the commutator is rotated too far to the left.

e. Remove alignment gauge and master and return assembly under press. Place a straight edge in a core slot and position a dial indicator on the commutator risers against the straight edge. Correct commutator to core alignment while completing the last 25 mm (1") of pressing.

f. Remove straight edge and dial indicator and remove assembly from press.

g. Repeat Steps a through d to ensure final commutator alignment is satisfactory.

WINDING ARMATURE

PREPARATION BEFORE WINDING ARMATURE

1. Inspect armature core for dirt, burrs, slot size, end plate clearance, and slot wedge size as instructed in previous sections of this Maintenance Instruction.

2. Ensure commutator riser slots are clean, are free of solder slivers, and have been fluxed.

3. Ground test commutator at 5000 V AC for 10 seconds prior to rewind.

4. Perform a commutator bar-to-bar resistance test as instructed in Section 5 of this Maintenance Instruction.

5. Place core and commutator assembly in a suitable stand. The stand should be constructed so that it is possible to rotate the assembly during the winding operation.

6. Lay out armature for winding as shown in Fig. 19.

7. Refer to Table I to determine the type of armature rewind kit required. The rewind kit can be determined by the type of bearing lubrication which will be used.

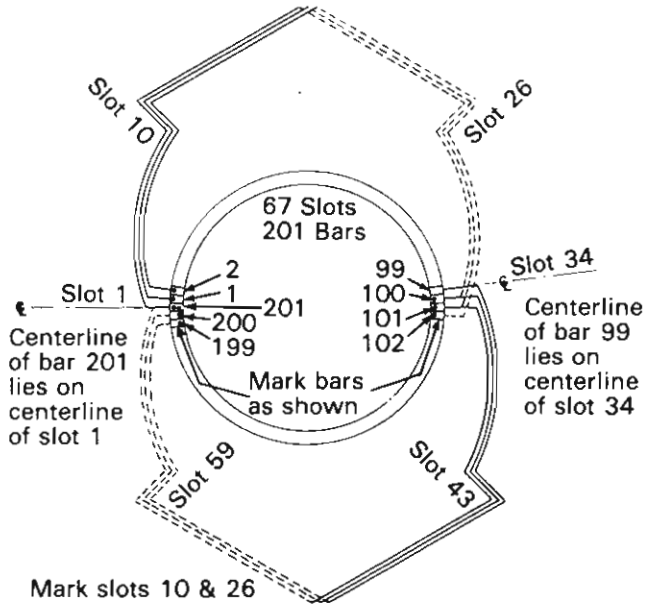

Fig. 19 – Armature Coil Winding Layout

8. If the commutator string band has been removed, fill the gap between the front insulation "V" ring and the outer edge of the commutator front steel "V" ring with insulating cement, Fig. 20, to provide an unbroken surface for "V" ring string band.

COMMUTATOR END COIL SUPPORT INSULATION

1. If the commutator has been removed and replaced, or if the six section mica ring behind the commutator, Fig. 20, has been damaged, install a new mica ring as follows.

   a. Place a strip of masking tape over the surface of the back side of the commutator riser as shown in Fig. 21. The tape is to prevent insulating cement from entering the commutator riser slots.

   b. Apply insulating cement under the projecting edge of the coil support until the cavity is completely full, Fig. 20. Pack the cement flush with the commutator side of the coil support. Also pack any balance weight pockets with insulating cement.

   c. Ensure coil support area is free of nicks and sharp edges.

Model	Bearing Lubrication	Rewind Kit Part Number And Remarks
D19	Open or Add Type	8290946 - will allow coil clearance at pinion end housing
D19	Sealed Grease	8255200 - pinion end housing must be machined for coil clearance
D29	Sealed Grease	8255200
D36	Open or Add Type	8290946 - substitute coil 8316881 for coil 8270530 and refer to Service Data Material List for filler and wedge strip and slot wedge part number
D36	Sealed Grease	8255200 - substitute coil 8313935 for coil 8240646 and refer to Service Data Material List for filler and wedge strip part number

Table I - Armature Rewind Kits

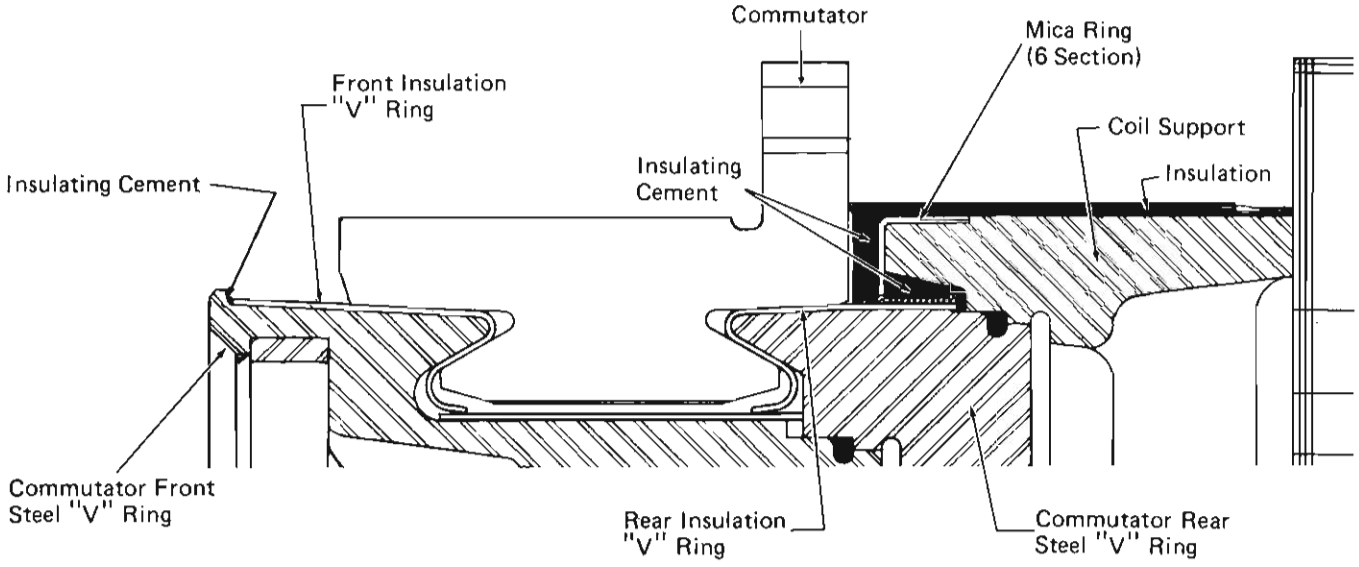

Fig. 20 - Commutator End Coil Support Insulation

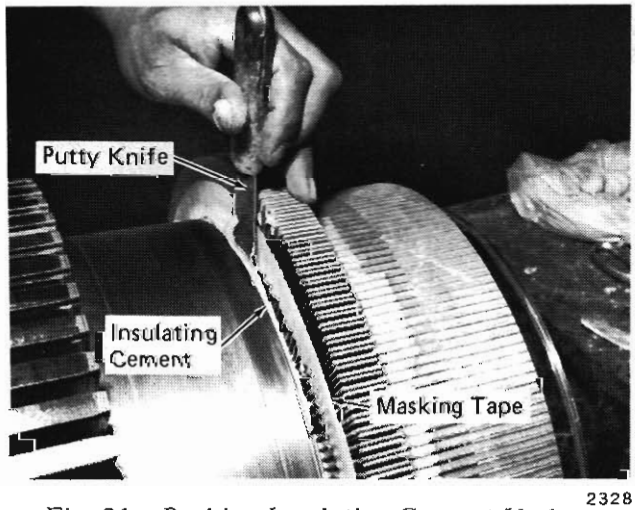

Fig. 21 - Packing Insulating Cement Under Coil Support

d. Brush shellac in the recessed portion of the coil support. While shellac is still wet, install six section preformed mica ring 8173531, tightly in the recess, Fig. 22. Shellac the recessed ends of the mica sections and overlap when installing. Tie down mica ring with one turn of temporary twine or masking tape, Fig. 21.

e. Pack the area between the mica ring, just installed, and the back of the commutator riser with insulating cement, Fig. 23. Pack the cement solidly, filling all voids, until area is flush with the top surface of the mica ring.

f. Remove temporary twine or masking tape. Fill any space that exists between the

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Fig. 22 – Installing Formed Mica Ring Behind Riser

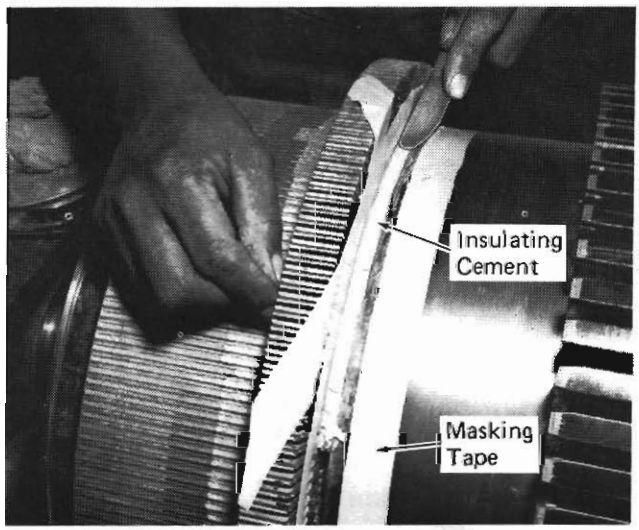

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Fig. 23 – Packing Cement Between Ring And Riser

edge of the mica ring and the coil support with insulating cement, Fig. 24. Ensure insulating cement is free of high spots and flush with the surface.

NOTE: The insulation over the coil support consists of insulation wound in with continous 0.13 mm x 19 mm (.005" x 3/4") fiberglass tape. If it is necessary to splice the fiberglass tape during the operation, use adhesive tape. Stagger the gaps of insulation layers so that no two gaps fall in the same line. Do not allow tape to build up in any area.

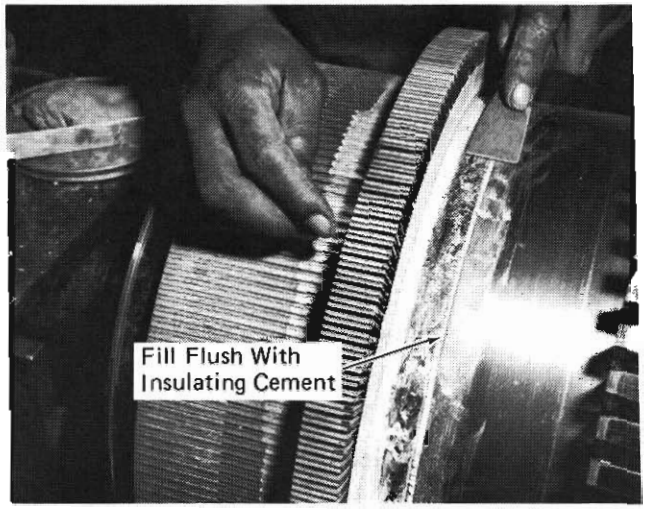

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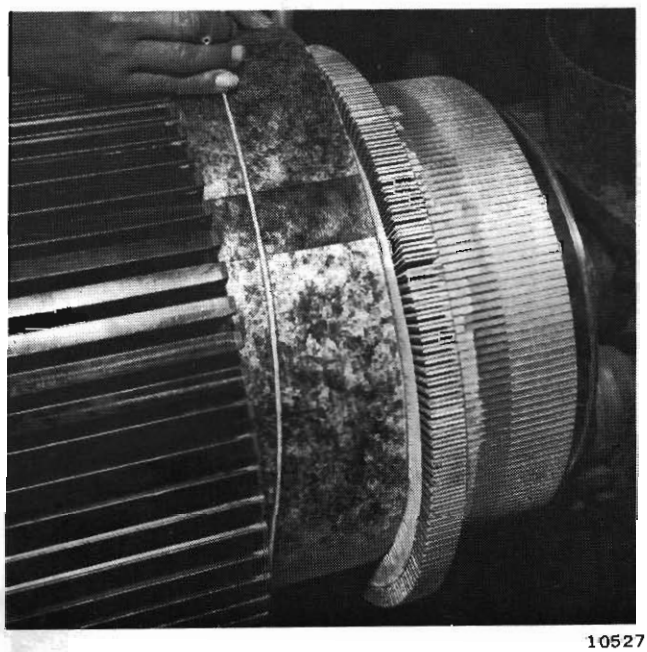
Fig. 24 – Filling Void Between Edge Of Ring And Coil Support

2. Brush shellac over the commutator end coil support between the back of the commutator riser and the armature core end plates. Shellac the overlapping ends of three section mica ring 8176428 and place around the coil support, Fig. 25. Butt one edge of each piece against the core end plate and position the joints approximately 60° from the joints in the underlying preformed mica ring. Tie down mica ring with one turn of temporary twine.

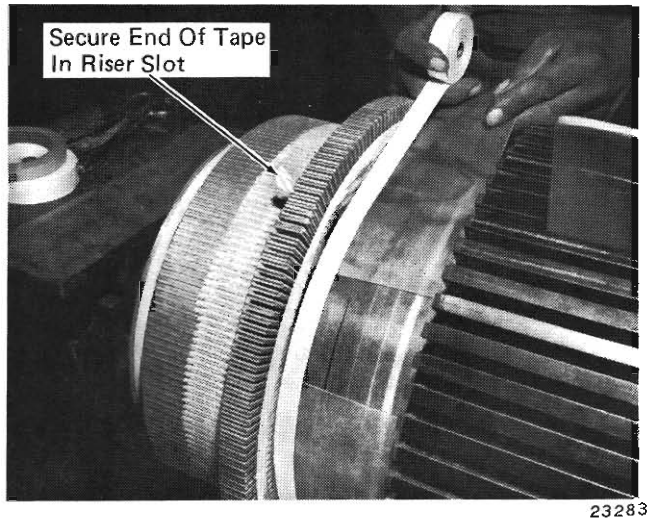


10527

Fig. 25 – Installing Mica Ring Over Coil Support

3. Fill any gaps that exist between the edge of the mica ring and the back of the commutator riser with insulating cement. Ensure insulating cement does not enter commutator riser slots. Keep insulating cement flush with top of ring.

4. When shellac under the mica ring is dry, remove temporary twine and apply shellac sparingly over the entire area. While shellac is still wet, rotate the armature and apply one turn of 0.13 mm x 19 mm (.005" x 3/4") fiberglass tape around the area close to the back of the commutator riser. The starting end of the tape can be secured by tying a knot in the end of the tape and slipping the tape through a slot in the commutator riser, Fig. 26.



23283

Fig. 26 – Winding In First Layer Of Insulation

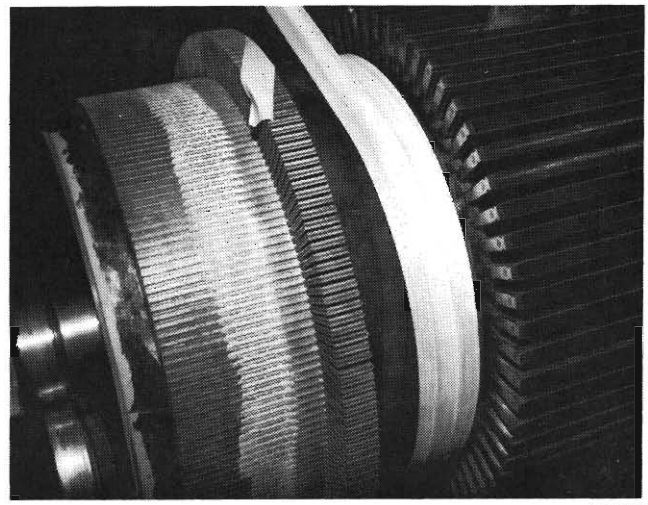
NOTE: When winding in insulation under the fiberglass tape, the tape must be pulled as tightly as possible to provide tight layers of insulation.

5. Wind in one three section layer of insulation 8179263 with ends butted together and sides butting the commutator riser. Do not cut the fiberglass tape from roll.

6. Continue to rotate the armature, moving the fiberglass tape to the core side of the insulation. When the core side is reached, continue rotating armature and apply one half lapped full layer of fiberglass tape, progressing toward the commutator riser. As the last turn of fiberglass tape is made, apply shellac sparingly over the entire area just taped. Do not cut the fiberglass tape from the roll.

7. Continue to rotate the armature and wind in, under fiberglass tape, three layers of insulation 8179264, consisting of nine pieces, or three pieces per layer (one layer of insulation 8179264, consisting of three pieces on Model D31). Butt ends of insulation and keep one edge against commutator riser. Stagger joints and apply shellac between successive layers as winding progresses. The last piece of insulation of the third layer should be inserted as the last turn of fiberglass tape reaches the core side. Ensure fiberglass tape is pulled and held tight at all times when winding in layers of insulation. When all pieces are in position, cut the fiberglass tape and tuck end under previous turn.

8. Apply one full half lapped layer of 0.18 mm x 38 mm (.007" x 1-1/2") fiberglass tape over insulation just installed, Fig. 27. Start fiberglass tape application flush with core side of insulation and make progressive turns toward the commutator riser. Finish off the last turn of fiberglass tape adjacent to the commutator riser by looping end under last turn.



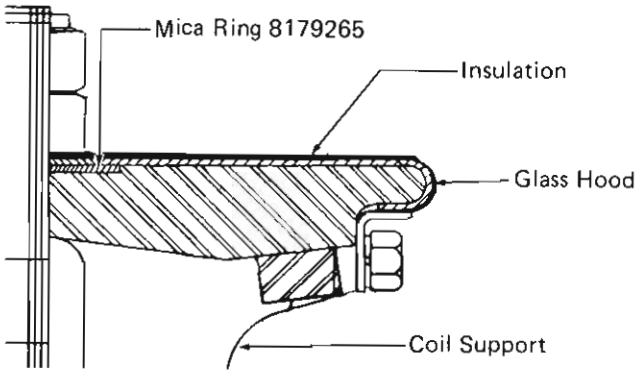
10529

Fig. 27 – Applying Half Lapped Layer Of Glass Tape

9. Shellac over entire area. While shellac is still wet, apply one layer of insulation 8166935 over the fiberglass tape. Allow a 13 mm to 25 mm (1/2" to 1") overlap of the insulation ends and butt one edge of the insulation against the back of the commutator riser. Secure end of insulation with adhesive tape.

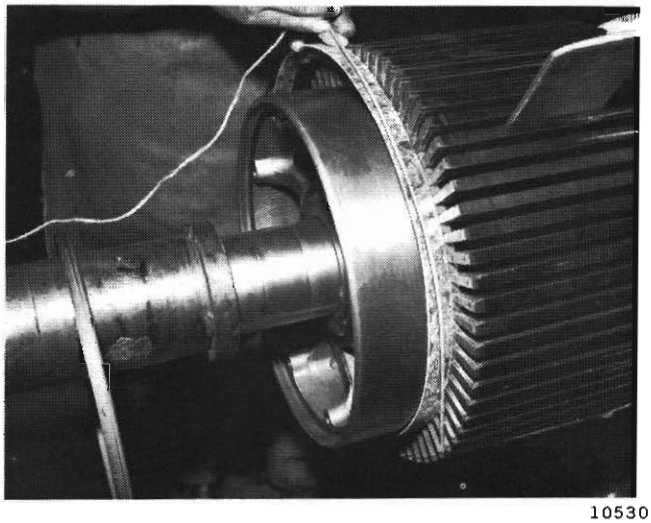
PINION END COIL SUPPORT INSULATION

1. Brush shellac in the recessed portion of the coil support, Fig. 28, and shellac the recessed ends of three section mica ring 8179265. While shellac is still wet, install mica ring in the recess with one side against the core end plates, overlapping the ends. Apply temporary holding twine no closer than 16 mm (5/8") from core end plates, Fig. 29, to allow next pieces of insulation to be installed while temporary twine is still in place.



23284

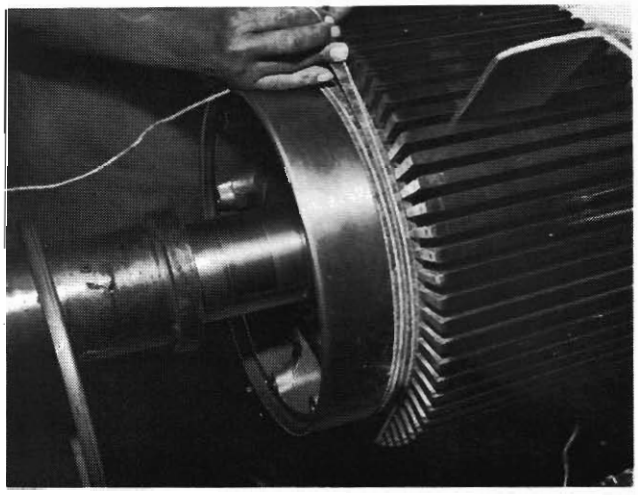
Fig. 28 - Pinion End Coil Support Insulation



10530

Fig. 29 - First Layer Of Mica At Recessed Area

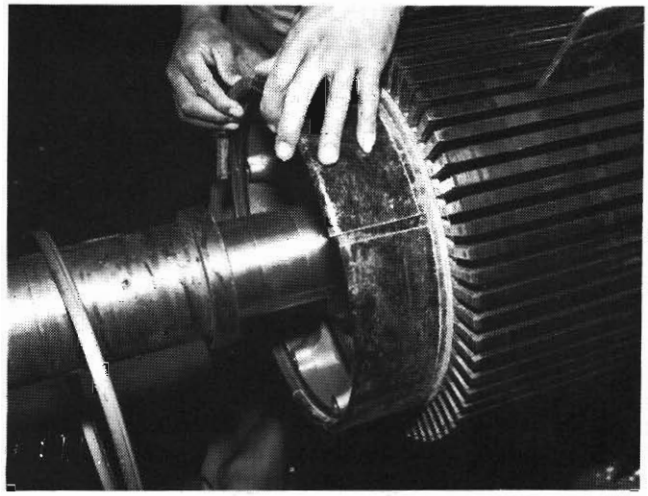
2. Brush shellac sparingly over the mica ring just installed and shellac the recessed ends of the three section mica ring 8179266. While shellac is still wet, install mica ring with one side tightly against the core as shown in Fig. 30. Apply temporary holding twine to hold ring sections in place and remove temporary twine used to hold mica ring 8179265.



10531

Fig. 30 - Second Layer Of Mica At Recessed Area

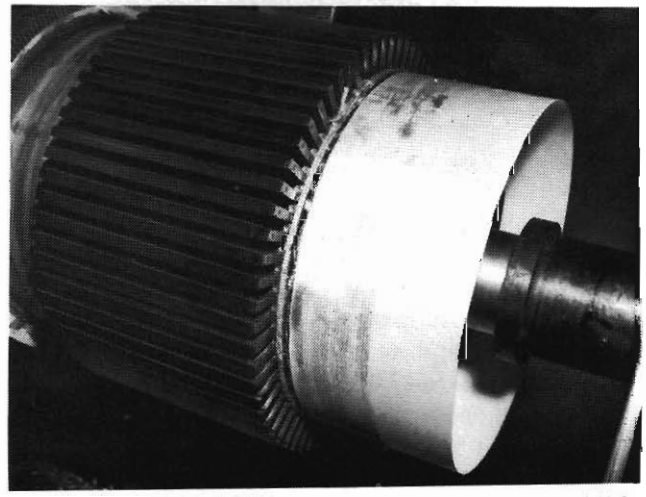
3. Brush shellac sparingly over entire coil support area and shellac the recessed ends of the preformed mica ring assembly 8173932. While shellac is still wet, install these sections over the coil support as shown in Fig. 31. Ensure the curled edge of the formed mica sections are tightly against the curved portion of the coil support.



10532

Fig. 31 - Installing Formed Mica Ring

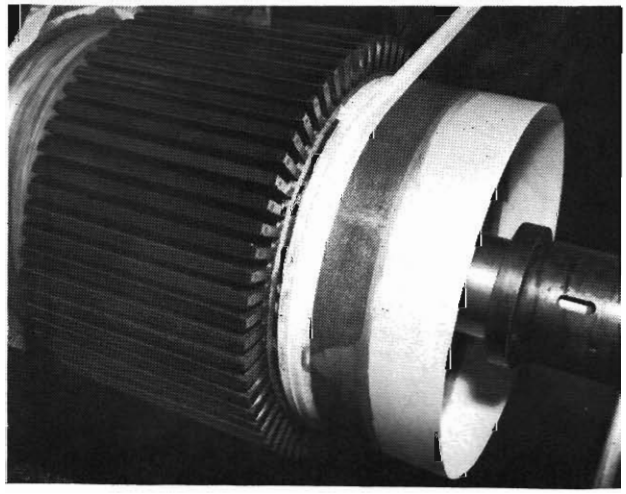
4. Remove temporary twine from mica ring 8179266 and apply shellac sparingly over entire flat portion of the preformed mica ring just installed. While shellac is still wet apply glass hood 8179267 over the ring. Place hood so one edge will line up with core side of the preformed mica ring. Allow the other edge to overhang the coil support, Fig. 32. Draw the glass hood tightly over the coil support and trim any cloth in excess of 13 mm (1/2") overlap. Secure glass hood with a piece of adhesive tape. Shellac over the entire flat area.



10533

Fig. 32 - Glass Hood Application Over Coil Support

5. Apply two layers of half lapped 0.51 mm x 25 mm (.020" x 1") fiberglass tape, as shown in Fig. 33 rotating assembly to facilitate application. Start tape at edge of glass cloth near core end plates, and progress across area to approximately 6 mm (1/4") from the curved edge of the underlying mica ring and return to starting point. The glass tape should be started exactly on the edge of the glass hood and as the one-half lapped layers progress toward the curved edge of the formed mica the amount of overlap should be decreased on the last few turns. On the return layer, as the tape is applied back toward the starting point, increase the overlap after a few turns to the full one-half overlap. This is done to avoid a sharp edge underneath the armature coils when they are wound in. Secure end of glass tape with adhesive tape.

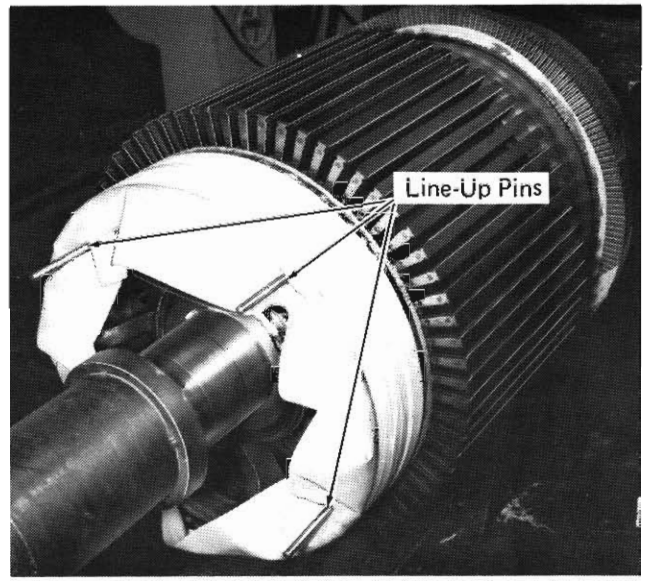


10534

Fig. 33 – Application Of Fiberglass Tape Over Glass Hood

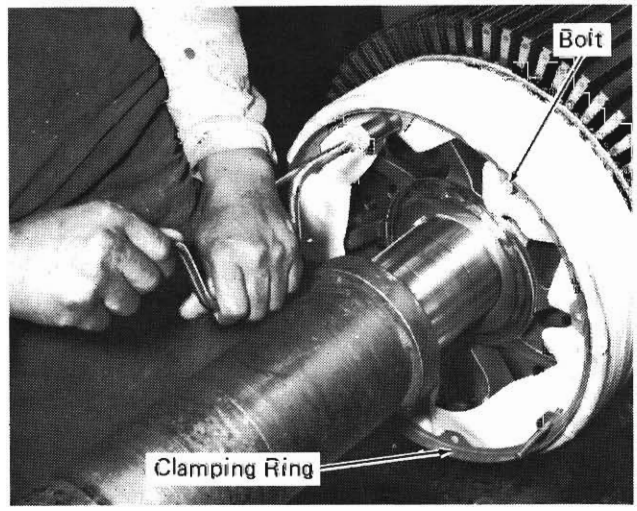
6. Brush shellac sparingly over the fiberglass tape just installed. When the shellac has dried, form the loose end of the glass hood over the radius of the coil support. Pull glass hood as tightly as possible and insert four line-up pins through the glass hood into the bolt holes for the clamping ring as shown in Fig. 34.

7. Slip the clamping ring over the four line-up pins. Remove the line-up pins, one at a time, and install bolt and lockwasher as line-up pin is removed. Do not tighten bolts until all eight bolts are installed and glass hood is pulled under clamping ring. Tighten bolts in clamping ring, Fig. 35, and trim off excess glass cloth at inside edge of clamping ring.



10628

Fig. 34 – Locating Pins In Position For Clamping Ring



10631

Fig. 35 – Clamping Ring In Position

8. Check fit between mica ring 8179266 and preformed ring. If any gap exists, fill flush with insulating cement to top of mica ring.

ARMATURE COIL SLOT INSULATION

1. Insert "U" piece insulation into armature core end plates at end of each coil slot. Position each "U" piece so that piece width extends one-half over the end of the end plate slot. Do not allow any portion of the "U" piece to extend into the coil slot.

2. Place one bottom filler strip in the bottom of each coil slot. Position each filler strip so that filler strip will overlap the "U" piece equally at each end of the coil slot.

NOTE: For D36 armatures, refer to Service Data for filler strip part number.

INSULATION AND WINDING ARMATURE COILS

The coils are designed to lay in without difficulty providing the core has been properly cleaned and gauged during preparation for rewind. The coil should be inserted by hand only, using a nylon mallet to drive coil leads into the commutator riser slots. When it is necessary to set the coils in the slot use a fiber block and a 0.5 kg (1 lb) rawhide mallet. Do not hit the coil excessively with the mallet.

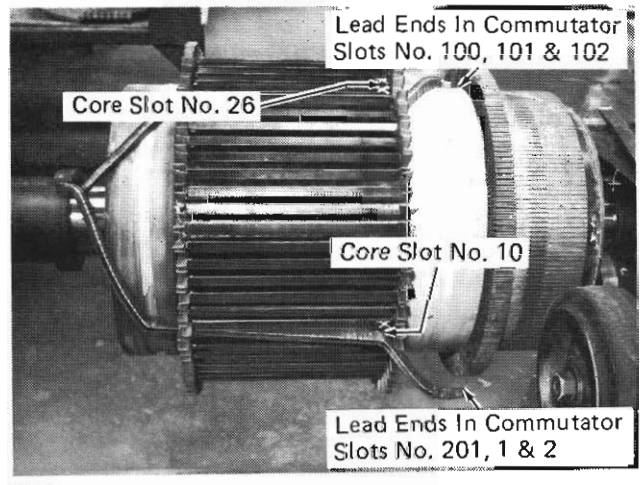
The insulation on the coils is a semi-rigid material and will stand no bending at the straight sections. Therefore, it is important that the coil be placed in the slot as horizontally as possible without bending or cracking the insulation.

The straight section of the coil should be centered in the slot, having equal space on each end of the core where the coil bends over the coil support. Failure to properly space the first coils will result in difficulty as the winding progresses causing unnecessary stress on the coil insulation and eventual coil failure in operation. When difficulty is experienced in laying in the coils, the winding operation should be stopped and cause of trouble corrected. Do not bend or twist the coils in an attempt to get them in their proper position. Coils should lay in evenly and uniformly.

Ensure "U" pieces and bottom filler strips are in proper position and proceed to wind in bottom coils as follows.

1. Ensure masking tape is removed from rear of commutator riser.

2. Refer to Fig. 19, Armature Coil Winding Layout, and insert bottom half of first coil in slot 26, as shown in Fig. 36. Press coil horizontally into slot. Position straight section of coil at bottom of slot before inserting coil leads into commutator riser slots. Position bottom coil leads of first coil in riser slots of bars 100, 101, and 102. Tap in place with nylon mallet. Insert middle neck filler plug on top of each bottom coil lead in the riser slot



10636

Fig. 36 - First Coil In Position

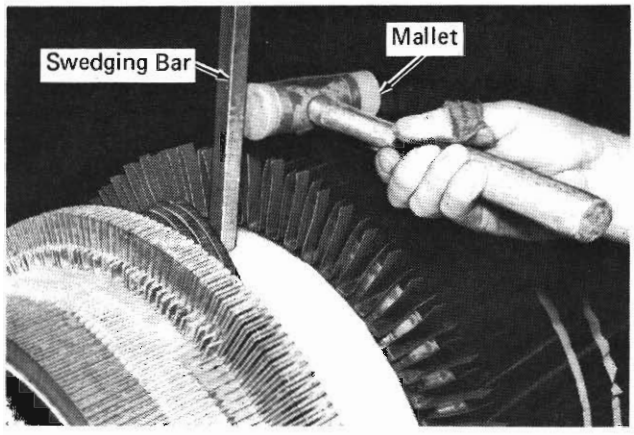
and set middle neck filler plug and lead at the same time. Keep back end of the plugs flush with the back side of the commutator riser bar. Do not allow plugs to extend beyond the back side of the riser, they may cause shorts between coils.

NOTE: If coil lead ends are loose in commutator slots, add 0.25 mm (.010") plate mica pieces in the mica section of the riser. Use care when inserting mica pieces to prevent damage to mica between riser. Only add pieces as required to prevent mica build-up between slots.

3. Continue to wind in balance of bottom coils, leaving top section of coils free of core. As the coils are placed into the core slots, slightly bend or form the coils over the coil support area to lay properly. Coils can be swedged or moved up tightly by using a swedge bar and mallet as shown in Fig. 37. Care must be used to prevent damage to coil insulation. As the lead ends are inserted into the commutator riser slots, the leads can be set by using a mallet and drift bar as shown in Fig. 38. Do not hit drift excessively.

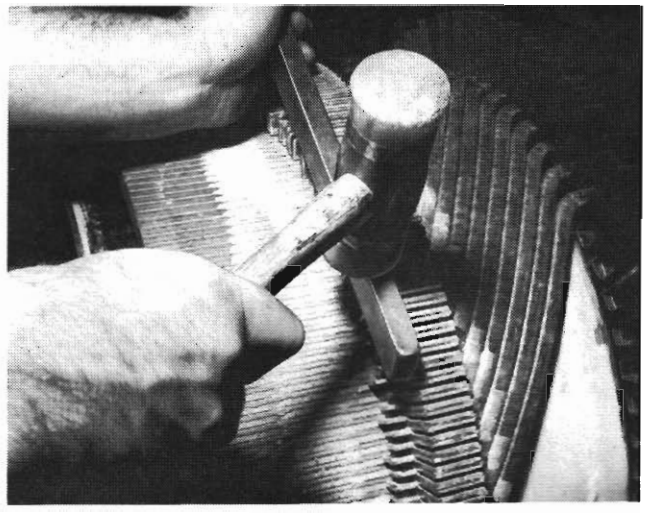
4. Fill all pockets behind the commutator riser with insulating cement, Fig. 39. Do not get insulating cement into riser slots.

5. When the pinion end of the top and bottom coils start to cross over, forming diamond sections, it is necessary to insert pads of insulation between the layers of coils. Do not make up pad assemblies until ready to use as pads will stiffen and dry in storage. Make up the pad assemblies as follows.



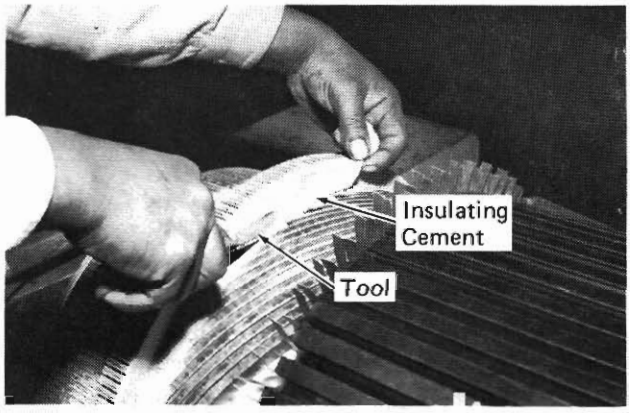
10536

Fig. 37 – Swedging Coil Bend Into Position



10537

Fig. 38 – Temporarily Setting Coil Ends And Plugs In Riser



23285

Fig. 39 – Filling Pockets Behind Riser

On Model D19 and D29, using coil 8240646 or Model D36, using coil 8313935, make up two pad assemblies 8245906, Fig. 40.

On Model D19 and D29, using coil 8270530 or Model D36, using coil 8316881, make up pad assembly 8245906 for the commutator end and pad 8270351 for the pinion end, Fig. 40.

Shellac each layer of insulation to hold in place and stagger the ends of the insulation approximately 51 mm (2") making up the pads so that as the pad is placed in position, the overlap at the ends will remain the same thickness.

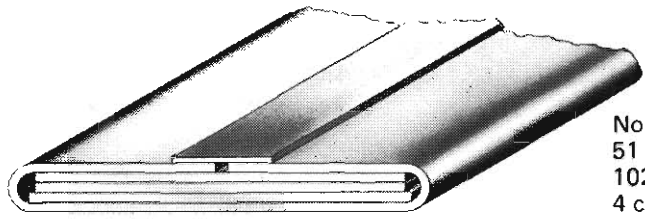
On Model D31, using coil 9084968, make up pad 9086385 for the commutator end and pad 9086382 for the pinion end, Fig. 41.

6. Insert pad assembly at pinion end where the coils start to cross, Fig. 42. It might be necessary to tap lightly on the coil ends, Fig. 43, to obtain clearance between the coil layers.

7. Continue to wind in bottom layer of coils, setting every coil in position with the fiber board and mallet, Fig. 44. When the coils start to cross at the commutator end, wind in the commutator end insulation pad assemblies as shown in Fig. 45. The commutator end pads can be folded back and tied to keep them out of the way, but do not crease or fold sharp enough to damage the assembly. As winding continues do not allow the pads to shift or bunch up.

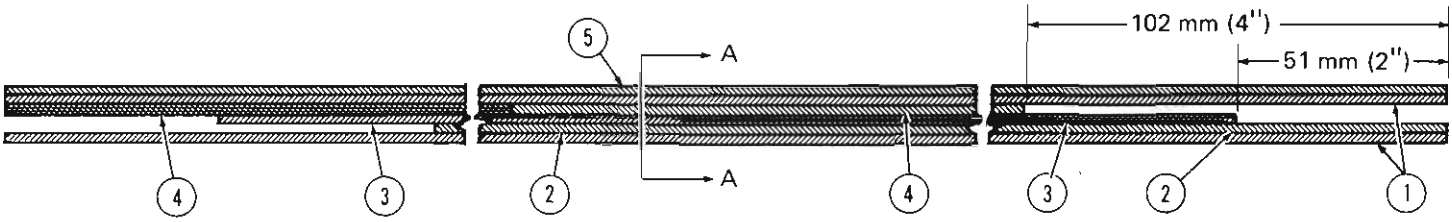
8. When the top half of the coils start to enter slots where the bottom coils are installed, place a filler strip between the bottom and top coil half before the top coil is placed in the slot. Refer to Service Data for D36 for center filler and wedge strip part number. Handle coils carefully to prevent damage when placing bottom part of coil in position under top part of coil.

9. After all the coils have been installed, set all the coils in the slot area, using the fiber block and mallet.



View A-A

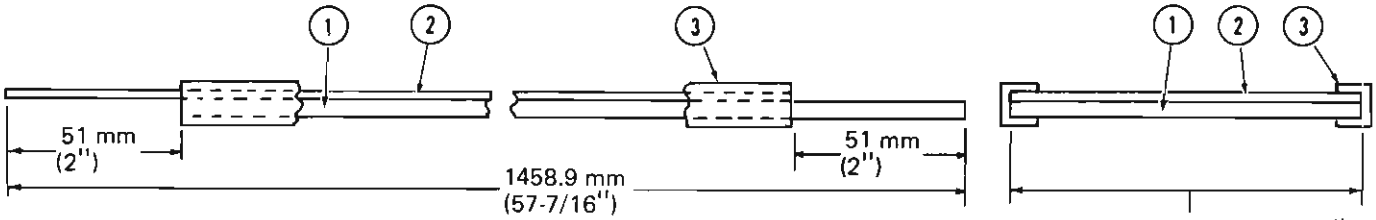
No. 2 starts at edge of No. 1 - No. 3 staggered in 51 mm (2") from edge of No. 1 - No. 4 staggered 102 mm (4") from edge of No. 1 - Layers 2, 3 & 4 consist of two pieces laid end to end.



Pad Assembly 8245906				Pad Assembly 8270351			
Item	Part Number	Qty	Insulation	Item	Part Number	Qty	Insulation
1	8176435	1	204.8 mm x 1458.9 mm (8-1/16" x 57-7/16")	1	8176436	1	171.4 mm x 1458.9 mm (6-3/4" x 57-7/16")
2	8245905	2	102 mm x 689.8 mm (4" x 27-5/32")	2	8270350	2	84.9 mm x 678.7 mm (3-11/32" x 26-23/32")
3	8176430	2	99.2 mm x 689.8 mm (3-29/32" x 27-5/32")	3	8176432	2	82.6 mm x 678.7 mm (3-1/4" x 26-23/32")
4	8176430	2	99.2 mm x 689.8 mm (3-29/32" x 27-5/32")	4	8176432	2	82.6 mm x 678.7 mm (3-1/4" x 26-23/32")
5	8188651	1	25.4 mm x 1524 mm (1" x 60")	5	8188651	1	25.4 mm x 1524 mm (1" x 60")

23286

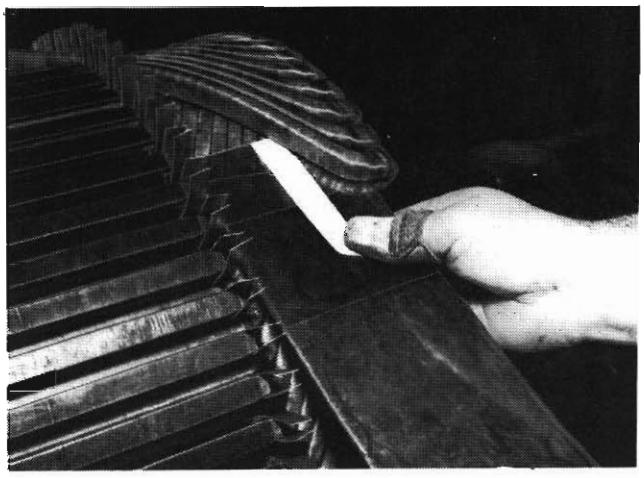
Fig. 40 - Model D19, D29, And D36 Armature Pad Assembly



Commutator End Pad Assembly 9086385			Pinion End Pad Assembly 9086382		
Item	Part Number	Insulation	Item	Part Number	Insulation
1	9086387	102 mm x 1379.5 mm x 0.64 mm (4" x 54-5/16" x .025")	1	9086383	98.4 mm x 1379.5 mm x 0.64 mm (3-7/8" x 54-5/16" x .025")
2	9086386	102 mm x 0.25 mm (4" x .010")	2	9086384	98.4 mm x 0.25 mm (3-7/8" x .010")
3	8339174	Mylar Film Tape 19 mm (3/4")	3	8339174	Mylar Film Tape 19 mm (3/4")

23287

Fig. 41 - Model D31 Armature Pad Assembly



10539

Fig. 42 - Inserting Pinion End Insulation Pad

10540

Fig. 43 - Shifting Coil Ends To Aid Pad Insertion

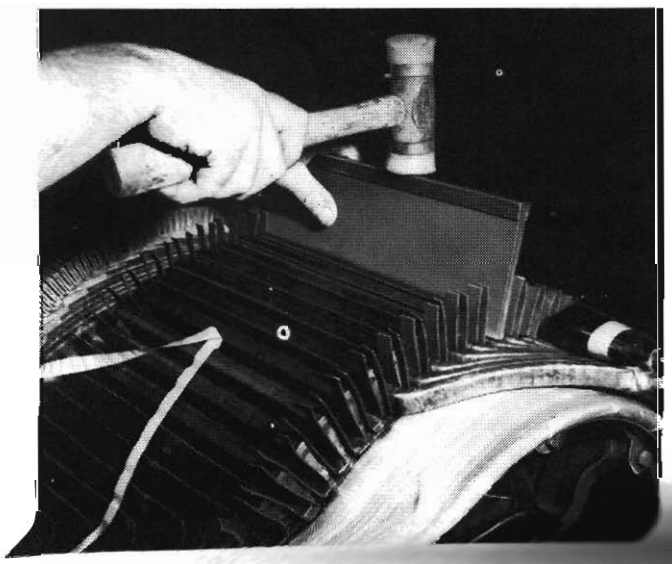
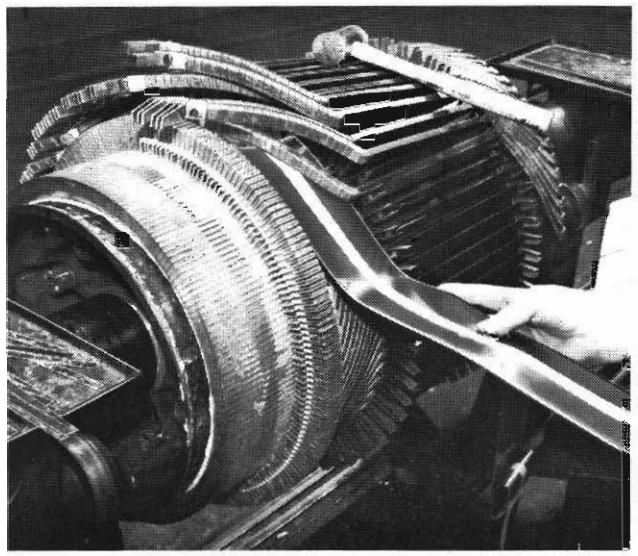


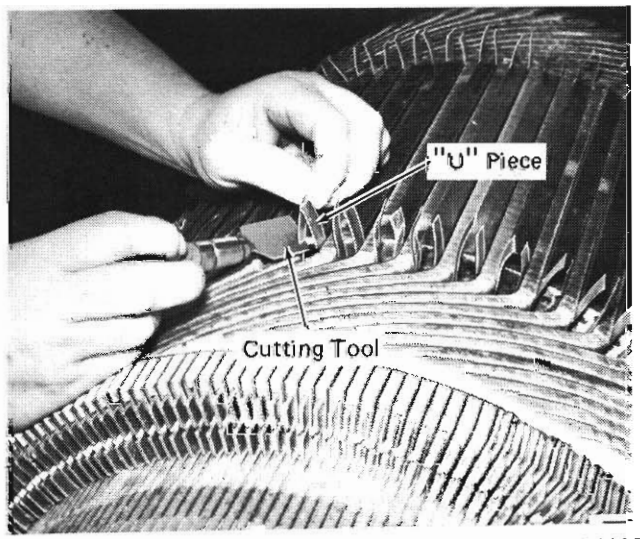
Fig. 44 - Setting Bottom Coils In Coil Slots



10630

Fig. 45 - Inserting Commutator End Insulation Pad

10. After all the coils have been set in the slots, cut off top of the "U" insulation pieces even with the bottom of the wedge slot. Use care not to damage the coil. Use cutting tool to cut the edge of the "U" piece, Fig. 46, and then tear "U" piece the rest of the way by hand.

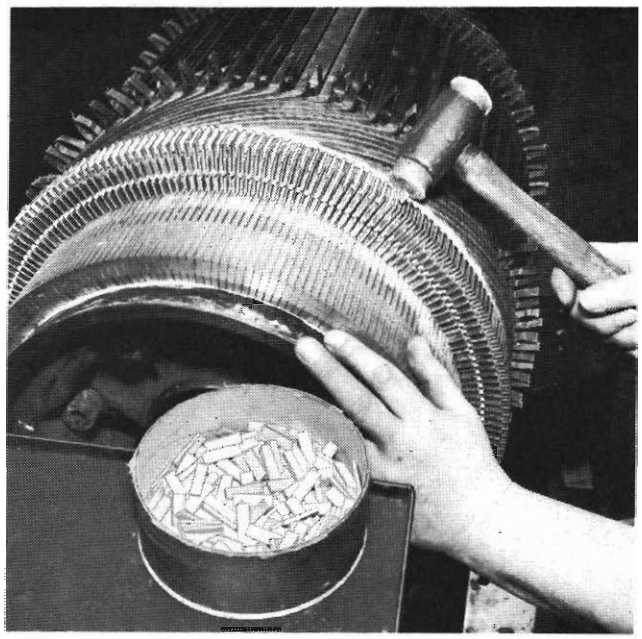


10635

Fig. 46 - Removing "U" Piece Ends

11. On armature risers not to be TIG welded, install top commutator neck fillers with one end flush with the back of the commutator riser bars. Lightly strike exposed top portions of top neck filler plugs with 0.5 kg (1 lb) rawhide mallet, Fig. 47.

coils.



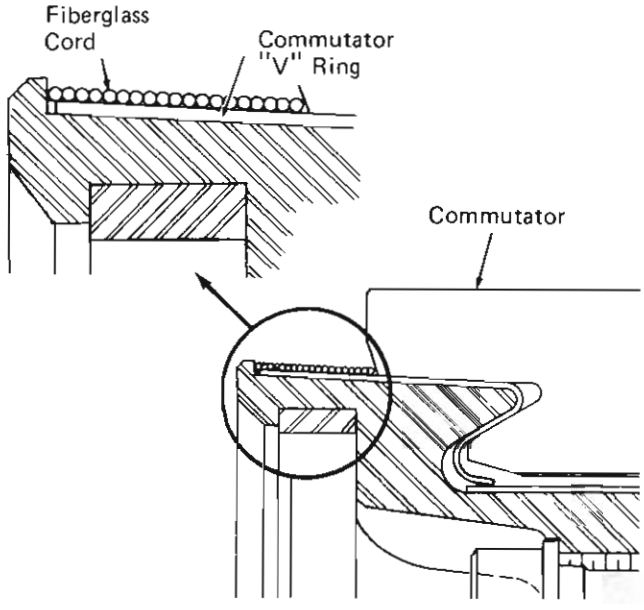
10634

Fig. 47 – Setting Top Lead And Top Neck Filler Plugs

COMMUTATOR END STRING BAND

All varnished or painted polyester string bands or epoxy coated string bands which require replacement should be replaced with fiberglass cord string band and teflon string band covering.

If the string band is being replaced with a fiberglass cord string band or if a new fiberglass cord string is required, refer to Fig. 48 and perform the following procedure:



23288

Fig. 48 – Commutator End String Band

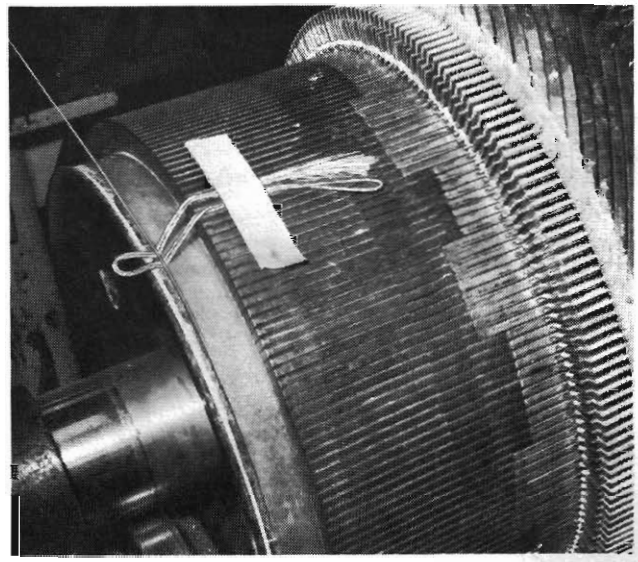
1. Remove any loose cement from commutator "V" ring.

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

NOTE: Epoxy resin and catalyst also available in bulk quantities and can be mixed in the proportion of 950 cc (1 qt) of polyester resin to 10 cc (.34 oz) of catalyst. These recommended proportions result in a mixture "pot life" of approximately nine days. Refer to Service Data for part numbers of polyester resin and catalyst.

3. Apply a liberal coating of epoxy resin with a 25 mm (1") brush to the commutator "V" ring. Do not allow the epoxy resin to work into the slots of the commutator.

4. Wind in one layer of glass cord over epoxy resin coating. Starting next to the commutator, secure one end of cord by overlapping one turn. Keep glass cord pulled tightly and keep turns as close together as possible. When there are approximately four turns left to make, form a loop of a short piece of the cord and wind under the remaining turns, leaving the loop and loose ends exposed as shown in Fig. 49.



10633

Fig. 49 – Installing Commutator "V" Ring String Band

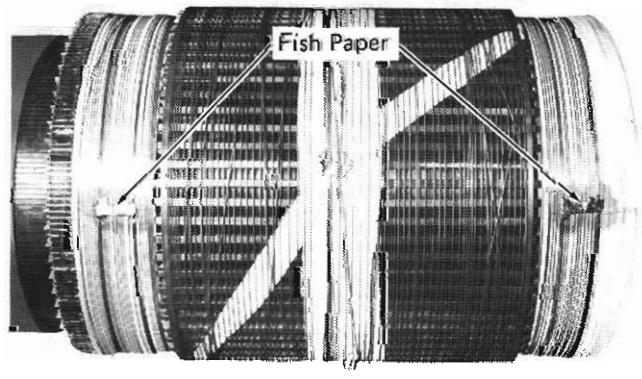
5. When all turns are completed, cut cord from spool and insert loose end through formed loop and carefully pull loose end under, but not out of, the turns. Cut all loose ends flush with the layer of glass cord. Apply a liberal coat of epoxy resin over the glass cord.

TEMPORARY BAND APPLICATION

A temporary banding operation is required to properly set the coils and insulation prior to wedging and final banding. The armature must be heated and while hot, temporary bands applied over the core and coil support area as shown in Fig. 50. The heating operation is required to soften the bonding agents in the insulation to assure an even pull down or setting of the coils and insulation. Apply temporary band to armature as follows.

1. Apply one turn of surgical tape around center of armature core and secure ends of tape. Insert one top wedge strip 8253781 (8313931 for D36) and one steel tension bar. The tension bar should be just wide enough to fit the coil slot and 324 mm (12-3/4") long (264 mm [10-3/8"] long for D36).

2. Apply two layers of half lapped surgical tape over pinion end and commutator end coil support area. While applying second layer of tape, insert a 50 mm x 100 mm x 0.64 mm (2" x 4" x .025") piece of fish paper under the tape at both support areas at a right angle to the tape at the area the banding wire will be soldered, Fig. 50. Make several turns of surgical tape in the center of the core, secure ends and make a loop with the tape ends. The loop will be used to secure the start of the temporary banding wire.



23289

Fig. 50 - Armature Temporary Banding

3. Place the armature in an oven preheated at 120° C (248° F). Allow armature to heat for 5 hours. Remove armature from oven.

NOTE: Banding operation must start within 15 minutes after removal from oven. Ensure tension bars are properly positioned before starting temporary banding.

4. Place armature in a banding lathe.

5. Secure the end of the temporary banding wire to the loop in the surgical tape at the center of the core. Apply a few turns of banding wire over the tape while regulating tension to 113 kg (250 lb).

6. Hold the 113 kg (250 lb) tension and move the carriage on the banding lathe, applying wide spiral turns toward the commutator end of the tension bars, then apply wide spiral turns toward the pinion end of the tension bars. Return wire back to the commutator end of core and then run off core area to the commutator end coil support area. Space wire so that 10 to 12 turns per 25 mm (1") are applied. When the band has progressed at least 38 mm (1-1/2") from the core, apply two 0.38 mm x 51 mm (.015" x 2") band clips over the fishpaper piece, Fig. 50, and under the next turn of wire. The banding clips should be long enough so that when bent over the band, for soldering, the clips will overlap three to four turns of wire.

7. Continue banding at 10 to 12 turns per 25 mm (1") until within 19 mm to 22 mm (3/4" to 7/8") from the back of the commutator riser. While wire is still under tension, bend over end of clips and solder band all the way across at the clips. Use flux and high temperature solder over each clip. Refer to Service Data for flux and solder part number. Do not cut banding wire, but run wire back across the core to pinion end and apply a temporary band to the pinion end coil support area. Apply this band starting 38 mm (1-1/2") from the core to within 19 mm to 22 mm (3/4" to 7/8") from the outer edge of the coil ends. Apply band and solder in a manner similar to the commutator end band. After soldering, cut only finish end of wire.

8. Remove armature from banding lathe and allow to cool to room temperature. After cooling, place armature in a winding stand. Remove temporary banding wire from each end of the commutator end band and at the core end of the pinion end band. This will leave two temporary bands 38 mm (1-1/2") from the core at each end. Remove steel tension bars.

9. Install commutator end and pinion end tension bands to diamond section of coils and adjust to 907 kg (2000 lbs) tension.

10. Ground test armature windings at 5000 volts AC for 10 seconds. If ground test is satisfactory, proceed to install coil slot wedges.

WEDGING COILS

The armature coils are wedged to prevent the coils from shifting during operation. Various thicknesses of wedge strips are used because of the variation of coil slots and coils. Each individual wedge must be gauged by the "feel" of the wedge when the wedge is being driven into the slot.

After the wedge is in place, a light tap can determine if the wedge is tight. If the wedge sounds solid, the wedge is tight. If not tight, there will be vibration in the wedge when tapped.

Care must also be taken not to get the wedges too tight. When the armature is heated, the coils will expand and cause overly tight wedges to buckle. This will result in loose wedges when the armature cools.

The objective during wedging is to distribute all the forces equally over the entire core surface. Uneven forces can bend the laminations to cause the wedges in one slot to be tighter than wedges in other slots.

Prior to driving the wedges, mark a line around the outside diameter of the core, approximately 89 mm (3-1/2") in from the edge of the pinion end, to provide a stopping point to be used in the proper extension of the wedges beyond the edge of the core.

On D19, D29, and D31 armatures install three slot wedges per slot. Install two wedges from the commutator end, driving the first slot wedge all the way through the slot to the mark made on the pinion end, following with the second wedge. Then install the third wedge from the pinion end. Wedge alternate slots all the way around the armature core, and then wedge the empty slots in the same manner.

On D36 armatures, install two wedges per slot. Install one wedge from the commutator end and then install the second wedge from the pinion end. Wedge alternate slots all the way around the armature core, and then wedge the empty slots in the same manner.

Start the wedge with the tapered side down, placing one in each slot as the first wedge is started. Use any combination of wedge strips required to obtain a tight fitting wedge.

Wedges may be driven into the slots by using an air hammer, driving head, and spindle bushing as shown in Fig. 51, or they may be driven in by hand using a rawhide mallet and drive key to start the wedges and a drive bar to position the wedges. Refer to Service Data for tool part numbers.

10632

Fig. 51 - Wedging Coils

NOTE: During wedging operation, filler strips may jam up between the ends of the wedges as they are driven into position. This will not interfere with the wedging so long as the next wedge fits tight in the slot. Cut build up between wedge ends flush with the top of the wedge and beyond ends of the outer wedge, being careful not to damage the coils.

Insulate the pinion end of the armature by placing pieces of insulation between adjacent coils and insert a "U" shaped piece of insulation between the top and bottom coils. Apply a ground test of 4600 volts for 10 seconds to the armature.

Ensure all commutator plugs are in place and properly positioned. Refer to Section 5, Commutator Bar-To-Bar Resistance Test and perform a bar-to-bar resistance test to commutator.

SOLDERING OR T.I.G. WELDING COMMUTATOR RISER

The operation of soldering or TIG welding the commutator risers to the coil leads should be considered as a very important operation in the winding of the armature to ensure a good bond between the leads and risers. Although the actual operation is not too complicated, previous preparations performed during winding such as proper cleaning and fluxing the commutator risers during lead removal, making certain the leads fit tight in the slots during winding, and proper setting of leads and filler plugs in the riser slots, will add up to a good connection and the elimination of high resistance between riser and coil leads.

There are three methods in which the operation can be performed:

1. T.I.G. welding
2. Induction soldering
3. Hand soldering

After soldering or T.I.G. welding, perform a commutator bar-to-bar resistance test as instructed in Section 5 of this Maintenance Instruction.

T.I.G. WELDING

T.I.G. (Tungsten-Inert-Gas) welding is a process by which the welding of metal is accomplished by creating an electric arc between a 2% thoriated tungsten electrode, and the metal to be welded in a inert atmosphere of argon gas.

NOTE: For best results, those armatures that were not T.I.G. welded during original installation should not be T.I.G. welded during rebuild.

INDUCTION SOLDERING

Apply soldering paste directly over the leads and riser, then proceed as specified by induction soldering machine manufacturer.

HAND SOLDERING

1. Place the armature in a lathe and machine top and face of the riser, being careful not to remove excessive material from the riser. Remove only enough to give a smooth clean surface.

2. Apply flux with a clean brush to the machined area of the riser, being careful not to flux behind the riser or onto the surface of the commutator.

3. Place the armature in an oven for approximately 6 hours to preheat to 115° C (239° F).

NOTE: Do not place the armature to be soldered in an oven that has armatures baking after varnish treatment, as varnish fumes will adhere to the flux and interfere with the soldering operation.

4. Remove the armature from the oven and place it at a convenient height in a horizontal position. Position the armature so the pinion end is approximately 150 mm (6") higher than the commutator.

NOTE: It is important that the armature be thus positioned to prevent solder from flowing into the winding during soldering operation to reduce the possibility of short circuits back of the risers.

5. Flux commutator risers in sections of about ten bars, as bars are soldered.

6. A gas heated soldering iron kit can be used or three soldering irons which are heated in a gas flame can be used. Three irons are recommended so that while one iron is being used, the other two are being heated and there is no interruption in the soldering operation. The bottom tip of irons should be filed semicircular so as to fit the 9.5 mm (3/8") groove between commutator neck and bars. The tip of soldering irons should be wide enough to cover two bars, so that while soldering one bar, the second bar is being heated. The proper temperature of the bar being soldered can be detected in two ways as follows:

   a. By actually touching strip solder to the commutator bar riser. If solder flows, temperature is high enough.

b. When bar has reached proper temperature, the pure tin solder on the commutator bars, coil leads and neck fillers will flow and small drops of solder will appear on top of the commutator bar riser.

NOTE: Keep irons hot at all times.

Rotate the armature so that the slot being soldered is always slightly above a horizontal centerline. Butt the soldering iron against the riser joint to be soldered and heat well. Apply strip pure tin solder to the front and top of the commutator neck as soon as possible. Make sure that the joint is hot enough to cause the solder to flow freely and not only warm enough to cause the solder to adhere to the front joint.

After soldering, cool the armature to room temperature. After cooling, place armature in a lathe and turn excess solder off the commutator neck. Check solder joints for evidence of poor soldering and resolder if necessary.

VARNISH TREATMENT

Upon completion of the coil winding operations, the armature should be vacuum impregnated with varnish and baked before applying the final bands. Varnish should be thinned to maintain Ford Cup No. 4 orifice viscosity at 250-325 seconds at 21.1° C (70° F) and a minimum specific gravity of 0.900.

NOTE: Ensure pinion end and commutator end coil diamond sections are free of foreign material. Ensure coils are not damaged in this area.

Refer to Fig. 52 for a typical varnish treatment installation and perform vacuum impregnation and baking of armature as follows:

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

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

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

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

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

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

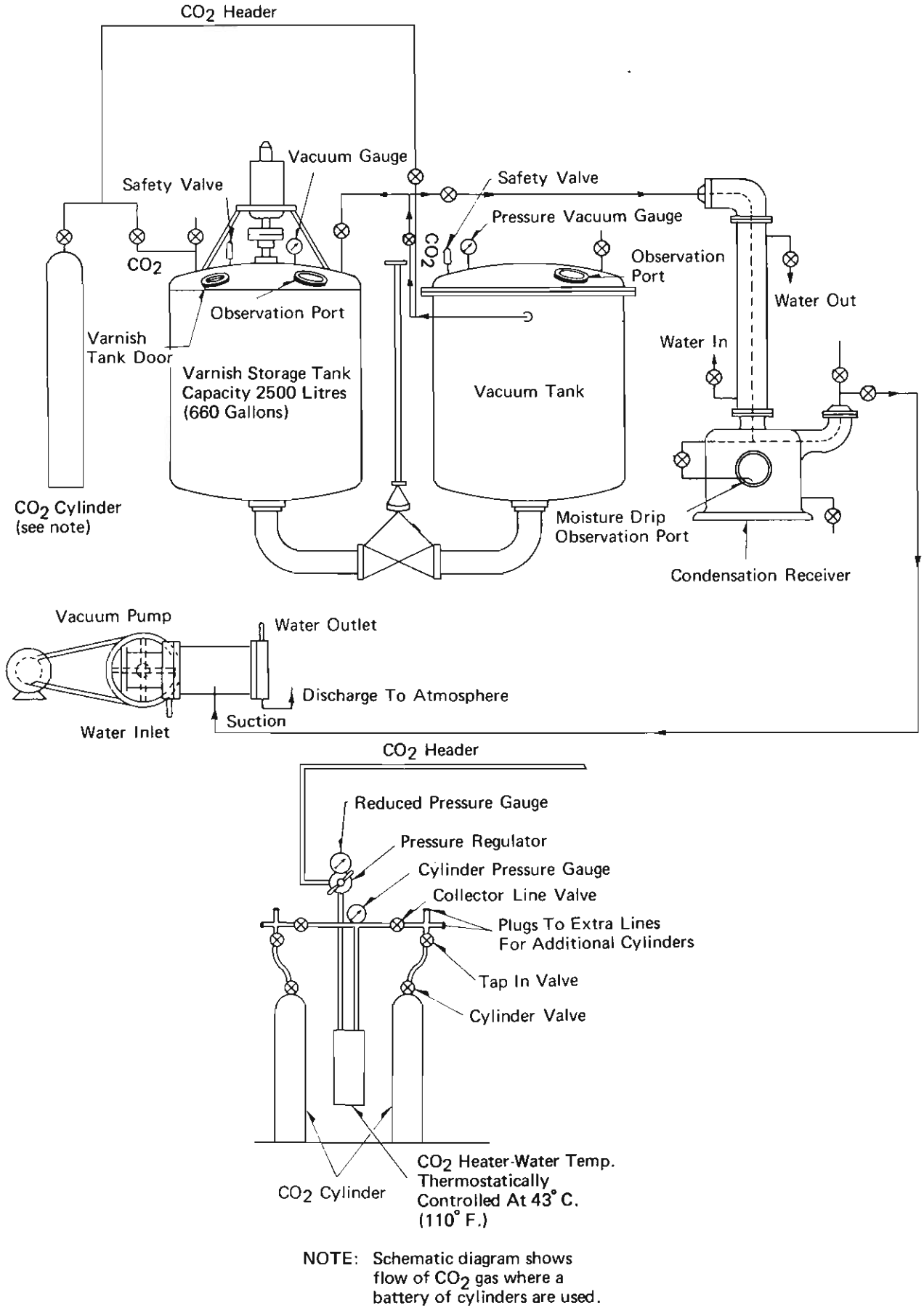
7. Reduce vacuum to zero with CO_2 additions. Check that varnish is at the proper level, then increase CO_2 pressure to 200-275 kPa (30-40 psi). Allow armature to remain under pressure for a minimum of 15 minutes to a maximum of 20 minutes.

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

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

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

11. Remove excess varnish from pinion end diamond pockets under the band.



NOTE: Schematic diagram shows flow of CO_2 gas where a battery of cylinders are used.

21994

Fig. 52 – Typical Varnish Treatment Equipment Installation

12. Place armature in a convection oven.

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

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

14. Remove armature from oven and while armature is still between 40°-60° C (104°-140° F), perform a ground test at 3200 volts for 1 minute.

15. If armature commutator bolts have been loosened for any reason during repair, torque commutator bolts to 305 N·m (225 ft-lbs.) using a torque wrench and a 4:1 reduction gear. Bolt tightening sequence should be 1-5-7-3-8-4-2-6 counting in a clockwise direction from any bolt. Tack weld bolts.

PERMANENT BANDING OF COILS

Current model traction motor armatures are banded with non-magnetic wire at the pinion end and banded with fiberglass tape at the commutator end. Those units manufactured with wire bands at both the commutator end and pinion end should have the commutator end band replaced with a fiberglass band when the band requires replacement.

NOTE: If a unit has a satisfactory wire band at the commutator end, the wire must have a covering of fiberglass tape and epoxy. Refer to Section 5, Tension Bands for procedure.

APPLICATION OF PINION END INSULATION

Before applying wire bands, a smooth and level insulation base must be applied as follows:

1. Remove temporary wire band surgical tape from band area.

2. Rotate armature and apply as much 0.13 mm x 19 mm (.005" x 3/4") fiberglass tape as required to obtain a level base. Apply tape with edge located 13 mm (1/2") from core end plates. Secure end of tape with 13 mm (1/2") adhesive coated mylar tape. Apply a coat of varnish over the tape.

3. Apply one turn of 0.13 mm x 19 mm (.005" x 3/4") fiberglass tape. Keep fiberglass tape tight at all times.

4. Wind in one layer of six section glass and mica insulation, glass side down, butting the ends together. Wind in with the fiberglass tape. Progress with fiberglass tape away from core about 51 mm (2").

5. Wind in a second layer of six-section glass and mica insulation, glass side up, butting the ends together. Stagger the starting edge of the glass and mica insulation 100 to 125 mm (4 to 5") from a joint of the first layer.

6. Continue with the fiberglass tape and wind in one layer of six-section treated asbestos insulation, butting the ends together. Keep one side of each insulation piece as close to the core as possible. Stagger the joints of the asbestos insulation about 51 mm (2") from the joints of the last layer.

7. Continue winding with fiberglass tape until a complete layer of one-third lap fiberglass is obtained across the top of the asbestos pieces. Secure end of fiberglass tape with adhesive coated mylar tape.

8. To prevent solder from entering the pockets located between the band insulation and the core, during banding operation, cover the openings with surgical tape. Apply one turn of the tape folded double over the pocket area at the pinion end. Do not overlap the band insulation. After one complete turn, continue with the tape not folded for two more turns. Keep tape against the edge of the band insulation and half lapped on the core.

PINION END LOWER BAND

1. Place armature in a banding lathe.

2. Position banding wire in groove of guide roll and lock wire in cam locks. Adjust banding tension to 159 kg (350 lbs) and locate first band so that the band is 19 mm (3/4") from the core.

3. Insert one banding clip under the first turn of wire opposite of every fifth wedge. Insert two extra clips at the starting point between the first and second regular clips. Clips should extend approximately 13 mm (1/2") beyond the first wire. There are a total of 16 clips.

4. Guide wire so that all turns, or strands, are tight against each other. Continue banding remainder of diamond section until band is at the width shown on Fig. 53. Bend up the four starting clips and trim clips to approximately 6 mm (1/4"). Tap clips down over wire.

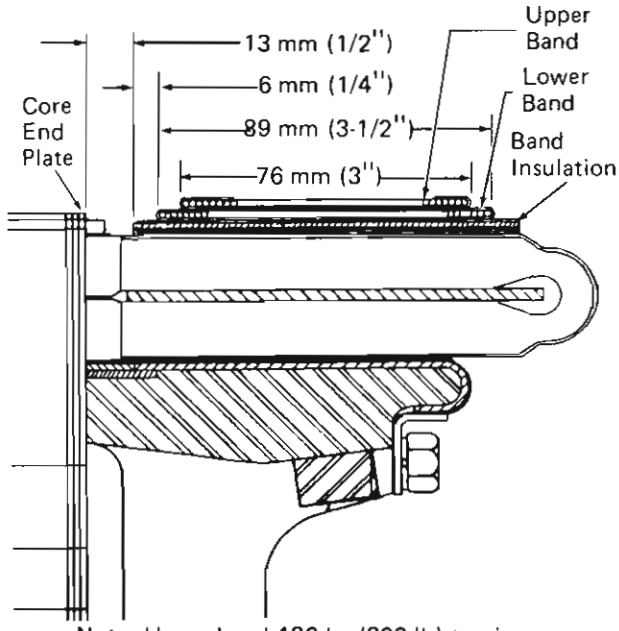


Fig. 53 – Pinion End Permanent Wire Band

5. Apply soldering flux to area of band between the four clips. Solder bands in this area. Back up armature to loosen tension on wire. Cut wire and bend wire back around the first starting clip at as near to band level as possible and trim wire in the form of a hook around the first clip. The hook end should not exceed 3 mm to 5 mm (1/8" to 3/16").

6. Flux and solder several strands at both edges of band over starting clips. Bend up, trim, and tap back onto the band the ends of all remaining clips. Close up any gaps in the band and set clips against the band. Do not nick the wire.

7. Flux and solder entire surface of the band. Solder the band all the way around and across the full width. A gas heated soldering iron is recommended for this operation. After soldering, rotate armature and remove any loose solder with a wire brush. Do not use a file or any sharp tool. Be careful not to nick the band at any time during banding or cleaning operation.

8. Apply one layer of 0.18 mm x 38 mm (.007" x 1-1/2") fiberglass tape, slightly overlapped. Locate tape 6 mm (1/4") in from either side of band. Area covered should be 76 mm (3") wide.

PINION END UPPER BAND

1. Set up banding lathe in proper position for the pinion end outer narrow band as previously done for lower band. While setting the proper band tension to 136 kg (300 lbs.), guide wire across pinion end lower band and apply two to four turns over the insulation adjacent to the lower band to prevent it from bulging during application of narrow band.

2. Insert one banding clip 54 mm (2-1/8") long under the first turn of wire, opposite of every fifth wedge. Space clips alternately to clips previously applied for lower band. Two extra clips should be inserted between the first and second regular clips as previously done for the lower bands. There are a total of 16 clips. Clips should extend approximately 13 mm (1/2") beyond first turn of wire band.

3. Apply banding wire to proper width, Fig. 53 being sure to maintain tight contact between turns. Finish with the four starting clips at top, then bend the starting clips up, trim clips to 6 mm (1/4") and tap them down over wire. Do not nick wire. Tap wire tightly against end bell at the four starting clips.

4. Flux and solder the four starting clips. When solder is hard, release tension, cut off excess wire, and bend both ends sharply around starting clips as near to band level as possible. Trim and set all remaining clips.

5. Flux and solder entire surface of the band. Solder the band all the way around and across the full width. A gas heated soldering iron is recommended for this operation. After soldering, rotate the armature and remove any loose solder with a wire brush. Do not use a file or sharp tool. Be careful not to nick the band at any time during banding or cleaning operation.

6. Apply a coat of varnish over pinion end bands. Refer to Fig. 54 for completed armature.

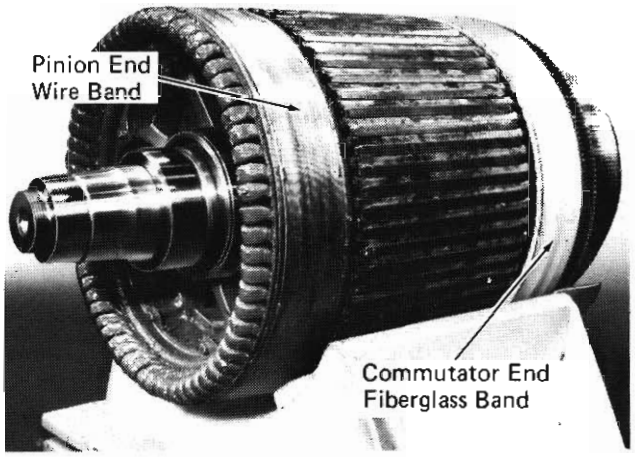


Fig. 54 - Model D29 Armature

APPLICATION OF COMMUTATOR END BAND

1. Place armature in banding lathe and remove commutator end steel tension band and protective asbestos blanket. Remove layer of protective tape applied before varnish impregnation operation.

2. Apply one layer of teflon insulation 8279203 around diamond section with edge located 19 mm (3/4") from core. Hold in place with adhesive coated mylar film tape.

3. Apply one layer of polyester glass tape 8339111 butting commutator riser. Hold in place with adhesive coated mylar film tape.

4. Apply one turn of acrylic banding tape 8279297 at 181 kg (400 lbs) tension over the fiberglass tape, starting in the center of the diamond section.

5. Locate band edge restraint 3 mm (1/8") from riser in Fig. 55. Feed in place under first turn of banding tape.

6. Apply a 152 mm (6") length of asbestos tape 8340741 centered longitudinally under butted joint ends of edge restraint. Pull ends of tape over rounded edges of edge restraint. Hold down with first layer of banding tape.

7. Apply 84 ± 2 turns, including five tie-off turns, of acrylic banding tape at 181 kg ± 11 (400 ± 25 lbs) tension between the rolled edges of the banding restraint as follows:

   Place a tape tie-off tool with the handle toward the core under the tape at the point where it is being fed onto the band. Rotate the armature until the tool is held down by three layers of tape lapped one on top of the other. Apply two more turns of tape while moving the carriage

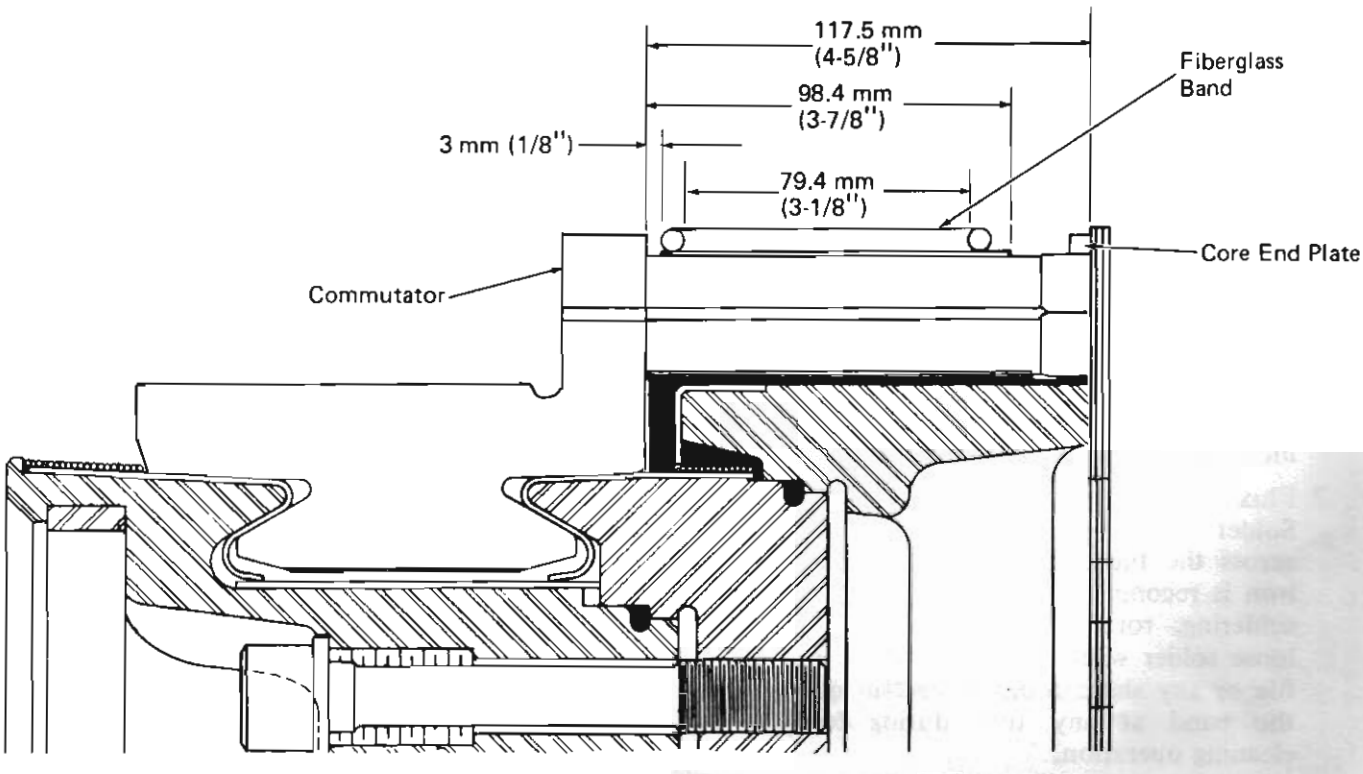


Fig. 55 - Commutator End Fiberglass Band

toward the commutator so that those layers butt against the two which hold down the tool. Apply one more turn of tape moving the carriage so that last turn covers the tape about 305 mm (12") beyond the tool and pass it under the tape where it bridges the tool. Pull the loose end to remove slack and remove the tool. Pull the loose end as tightly as possible and trim it where it emerges from the band. A total of 84 ± 2 turns including turns used for tie-off should have been made.

8. After the fiberglass bands are applied, place 90 mm (3-1/2") wide plastic film over band with edge of film flush with the outer edge of the band edge restraint on the core side.

9. Cover the film with a layer of pressure sensitive tape. Ensure the tape only comes in contact with the plastic film and not the fiberglass bands.

10. Thread 19 mm (3/4") rayon tape through tension device and secure end of tape to commutator riser and adhesive coated mylar film tape. Wind in a silicone rubber pad 101 mm x 2 mm (4" x 3/32"), approximately 1.5 m (5 ft) long under one layer of 19 mm (3/4") rayon tape at 113-136 kg (250-300 lbs) tension. Tie-off tape at center of winding.

11. Cure the bands by placing armature in a recirculating hot air oven for 1-1/2 hours at 175° ± 5° C (347° F ± 9°).

12. After removing armature from oven, allow it to cool below 32° C (90° F) before removing rayon tape, silicone pad, adhesive tape, and plastic film. Refer to Fig. 54 for completed armature.

FINAL ASSEMBLY

If the pinion end inner oil ring was removed, the ring should be reapplied at this time. Refer to Armature Inspection And Reconditioning, Section 5, for procedure. Also refer to Commutator Undercutting, Dynamic Balance, and De-Burring Commutator sections of Section 5 if required.

SERVICE DATA

EQUIPMENT LIST

Air Hammer, Slot Wedge	8147511
Driving Head	8142055
Spindle Bushing	8147512
Block, Fiber	8133105
Bolt, Lifting, Commutator End	8174221
Bolt, Lifting, Pinion End	8067122
Chisel, Commutator Leads	8133100
Chisel, Lead End Removal	8133100-D2
Chisel, Lead Splitting	8269134
De-burring Tool, Commutator	8270339
Drift, Coil Winding	8133098
Drift, Riser Straightening	8133097
Drive Bar, Slot Wedge (manual)	8133116
Drive Key, Slot Wedge (manual)	8133115
Driving Wedge (lathe), Armature Shaft	8164610
File, Core Slot	8133205
File, Slot Wedge	8133177
Fixture, Armature Turning	8287215
Fixture, Wire Locking	8304245
Gauge, End Plate	8133273
Gauge, Slot Alignment	8133164
Gauge, Slot Wedge	8133176
Gear, Reduction, Commutator Bolt Tightening	8064963
Hone Kit (less motor)	8431585
Megger, Insulation Resistance	8174880
Leads, 4 m (12') Long	8174878
Case, Carrying	8178879

Ohmmeter, Low Resistance (commutator bar-to-bar)	8068118
Leads	8107968
Puller, Pinion	8239217
Sticks, Armature Banding (70 required)	8064960
Soldering Iron Kit, Gas Heated	8164609
Scraper, Commutator Slots	8238105
Scraper, Insulating Compound	8133099
Tool, Cutting (coil slot "U" piece)	8133109

Commutator And Shaft Removal-Replacement Tools

Adapter, Pressing, Commutator End (used with pressing truck 8142293 and adapter 8268633)	8268830
Truck, Pressing (commutator and shaft)	8142293
Adapter, Commutator End (shaft removal)	8268833
Adapter, Pressing, Commutator End (shaft installation - used with pressing sleeve 8268831, clearance gauge 8268832, and pressing truck 8142293	8268829
Gauge Clearance (used with pressing adapter 8268829 and pressing sleeve 8268831)	8268832
Sleeve, Shaft Pressing	8268831
Gauge, Bar, Commutator Bar To Core Slot Lineup	8268834
Gauge, Scope, Commutator Bar To Core Slot Lineup	*File No. 903

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

MATERIAL LIST

Kit, Armature Rewind

D19 and D29 with open or add type bearing lubrication	8290946
D19 and D29 with sealed grease type bearing lubrication	8255200

NOTE: A rewind kit is not available for the Model D31 or D36 armature. A rewind kit can be made by using kit 8255200 or 8290946 and substituting the following items.

D31 with sealed grease bearing lubrication

	Supplied With Kit 8290946	Substitute
Armature Coil	8240646	9084968

D36 with open or add-type bearing lubrication

	Supplied With Kit 8290946	Substitute
Armature Coil	8270530	8313935
Filler Strip, Bottom	8245904	8313933
Filler And Wedge Strip, Center	8179269	8313932
Wedge Strip, Top	8253781	8313931
Filler And Wedge Strip, Top	8253782	8313929
Filler And Wedge Strip, Top	8253783	8313930
Armature Slot Wedge	9095786	8313928

D36 with sealed grease bearing lubrication

	Supplied With Kit 8255200	Substitute
Armature Coil	8240646	8316881

(Remaining items are to be replaced the same as for D36 motor with open or add-type bearing lubrication.)

NOTE: The material listed below is required in addition to the Armature Rewind Kit.

	Part No.
Cement, Insulating, 3.8 litres (1 gal)	8198930
Compound, Silicone Rubber	8126276
Cord, Glass, 366 m (400 yd) roll	8301227
Kit, Epoxy Resin	8260298
Compound, Epoxy Resin, 3.8 litres (1 gal)	8234315
Curing Agent, Epoxy Resin Compound, 56 g (2 oz)	8234316
Enamel, Red Air Drying	
1 litre (1 qt)	8061130
19 litre (5 gal)	8048876
Shellac, Orange, 3.8 litres (1 gal)	8211194
Solder, Flux, 0.5 kg (1 lb)	8122570
Solder, Flux, 3.8 litres (1 gal)	8068869
Solder, Hi Temp, 2.8 mm (.109") diameter, 32 kg (70 lb) spool	8160923
Solder, Tin Base, No. 8 wire, 23 kg (50 lb) spool	8225761
Solder, Sil-Fos	8004440
Tape, Adhesive Coated Mylar Film, 13 mm (1/2")	8188353
Tape, Polyester Glass, 0.25 mm x 25 mm (.010" x 1")	8339111
Tape, Surgical, 33 m (36 yd) roll	8122565
Tape, Teflon, 0.13 mm x 95 mm (.005" x 3-3/4")	8166934
Varnish, 3.8 litres (1 gal) Armature Baking	8460836

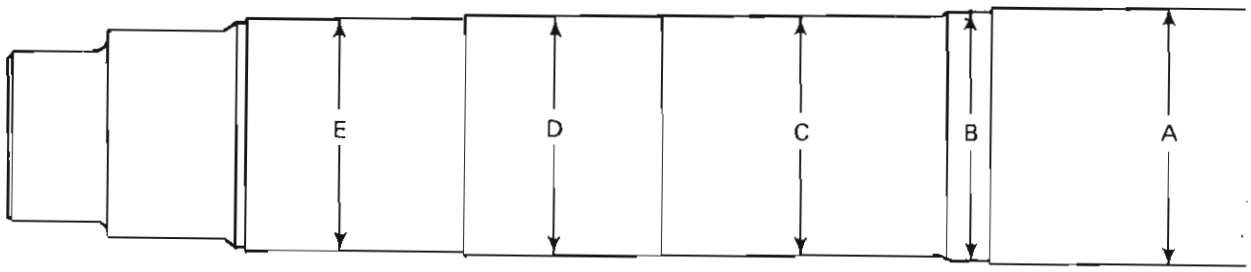
*Varnish, Electrical Insulating - Modified Polyester Y-432 (Sterling Varnish Co.)
Thinner Solvent For Above Varnish
Chevron No. 1300 Solvent
Thompson - Hayward Chemical Company No. 2026 Solvent
**Xylol Thinner
An alternate thinner solvent may be blended using the following materials:
Mineral Spirits (Rule 66 Type Thinner) 80%
Butyl Acetate - Technical Grade 20%

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

*To be used where compliance with pollution control regulations is required.
**Xylol may be used as a substitute thinner, however, Xylol DOES NOT comply with pollution control regulations.

Wire, Temporary Banding, 1.63 mm (.064")	8077233

ARMATURE SHAFT DIMENSIONS (Standard And Oversize)



D19 And D29	A Dimension	B Dimension	C Dimension	D Dimension	E Dimension
8307431 Standard	110.548 mm $^{+0.000}_{-0.013}$ ($4.3523'' \, ^{+.0000}_{-.0005}$)	110.49 mm $^{+0.00}_{-0.03}$ ($4.350'' \, ^{+.000}_{-.001}$)	106.223 mm $^{+0.000}_{-0.013}$ ($4.1820'' \, ^{+.0000}_{-.0005}$)	106.197 mm $^{+0.000}_{-0.013}$ ($4.1810'' \, ^{+.0000}_{-.0005}$)	101.702 mm $^{+0.000}_{-0.013}$ ($4.0040'' \, ^{+.0000}_{-.0005}$)
8307432	110.675 mm $^{+0.000}_{-0.013}$ ($4.3573'' \, ^{+.0000}_{-.0005}$)	110.62 mm $^{+0.00}_{-0.03}$ ($4.355'' \, ^{+.000}_{-.001}$)	106.350 mm $^{+0.000}_{-0.013}$ ($4.1870'' \, ^{+.0000}_{-.0005}$)	106.324 mm $^{+0.000}_{-0.013}$ ($4.1860'' \, ^{+.0000}_{-.0005}$)	101.702 mm $^{+0.000}_{-0.013}$ ($4.0040'' \, ^{+.0000}_{-.0005}$)
8307433	111.13 mm $^{+0.38}_{-0.00}$ ($4.375'' \, ^{+.015}_{-.000}$)	111.13 mm $^{+0.38}_{-0.00}$ ($4.375'' \, ^{+.015}_{-.000}$)	106.86 mm $^{+0.38}_{-0.00}$ ($4.207'' \, ^{+.015}_{-.000}$)	106.86 mm $^{+0.38}_{-0.00}$ ($4.207'' \, ^{+.015}_{-.000}$)	102.24 mm $^{+0.38}_{-0.00}$ ($4.025'' \, ^{+.015}_{-.000}$)
D36					
8312457 Standard	110.548 mm $^{+0.000}_{-0.013}$ ($4.3523'' \, ^{+.0000}_{-.0005}$)	110.49 mm $^{+0.00}_{-0.03}$ ($4.350'' \, ^{+.000}_{-.001}$)	106.223 mm $^{+0.000}_{-0.013}$ ($4.1820'' \, ^{+.0000}_{-.0005}$)	106.197 mm $^{+0.000}_{-0.013}$ ($4.1810'' \, ^{+.0000}_{-.0005}$)	101.702 mm $^{+0.000}_{-0.013}$ ($4.0040'' \, ^{+.0000}_{-.0005}$)

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MATERIAL LIST

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

Liquid Cleaner (pinion application)
- 19 litre (5 gal) Can 8365668

NOTE: The effectiveness of liquid cleaner is reduced after extended storage. Cleaner stability is at least 6 months if stored at temperatures below 24° C (75° F). Reduced stability will result if the cleaner is stored at higher temperatures.