



MAINTENANCE INSTRUCTION

TRACTION MOTOR ARMATURE INSPECTION AND RECONDITIONING

INTRODUCTION

In order to ensure satisfactory performance, the traction motor armature should be subjected to a thorough mechanical and electrical inspection and be reconditioned as necessary. This bulletin outlines the procedure that should be followed in making such an inspection and for performing the required reconditioning. Upon completion of these procedures, the traction motor armature will qualify for return to service.

CLEANING

Prior to making any inspections, the armature should be thoroughly cleaned and dried. Such cleaning can be performed as outlined below.

The armature may be cleaned by blowing off all loose dirt and carbon dust, both from the outside and inside of the armature using high volume, low pressure dry air, and by using a fiber brush and Stoddard solvent (ASTM-D474-40). This solvent is non-toxic and has a flash point of 115° F. It also has a fairly fast rate of evaporation.

CAUTION: The usual safety precautions that apply to inflammable fluids should be observed. Provide adequate ventilation when any type of solvent is being used.

After the armature has been cleaned, blow off as much of the solvent as possible using high volume, low pressure dry air. Let the armature stand until all remaining solvent has evaporated before making any electrical checks.

Mechanical inspection can be made on the shaft and armature during the period when the remaining solvent is evaporating.

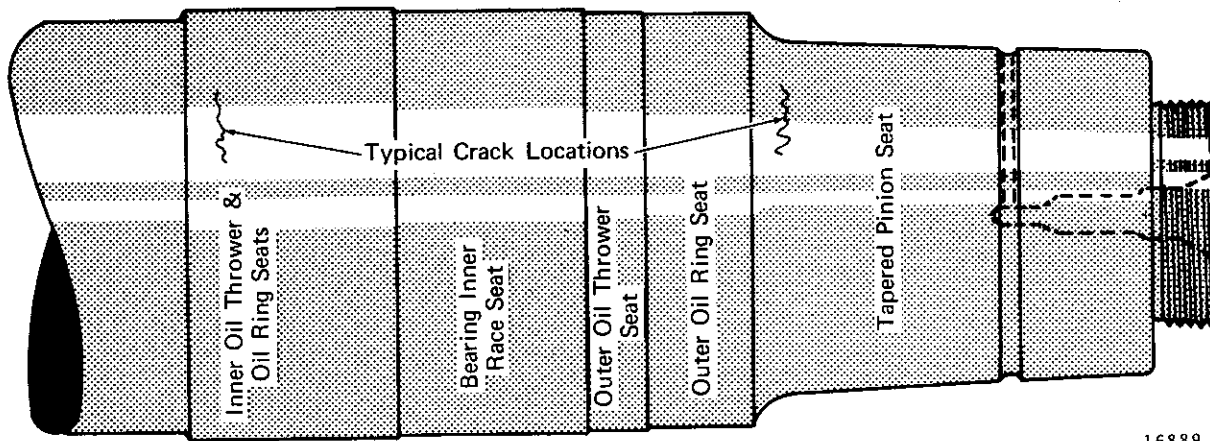
MAGNAFLUX INSPECTION

It is advisable to magnaflux the shaft before dimensional checks are made to determine if it will qualify for reuse. Make certain that the shaft is thoroughly clean, free of all rust, dirt, and oil. Check the shaft for residual magnetism either by applying magnaflux powder at the end of the shaft and observing for adherence, or suspending a short length of iron or steel wire at the end of a piece of string near the end of the shaft, and observing any attraction of the wire to the shaft. If no attraction is noted for either method, it will be necessary to magnetize the shaft.

This can be accomplished by using a magnaflux unit capable of producing 500 to 700 amperes of current and wrapping three turns of No. 0000 flexible cable around the ends of the shaft to be magnafluxed. Then, by applying current to the cable turns, the shaft will be sufficiently magnetized to be checked.

After magnetization, the magnaflux powder should be applied sparingly to the tapered pinion seat and adjacent machined surfaces. Any circumferential indications or defects are causes for rejection. These usually occur at the pinion end especially on the tapered section, Fig. 1.

Service history has indicated that longitudinal indications have little effect on service life, therefore, these specifications do not include inspection for indications in that direction. Any longitudinal marks on the shaft that have raised edges should be blended in to allow proper fit of parts that will be assembled to the shaft.



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Fig. 1 – Circumferential Defects

If any cracks are found, regardless of their direction, location or extent, the shaft must be replaced.

If the shaft is found to be satisfactory after magnaflux inspection, it should be further qualified for reuse by the dimensional inspection that follows.

DIMENSIONAL INSPECTION

Inspect the threads on the pinion end of the shaft. If threads are nicked or slightly damaged, they may be reworked by using armature shaft die 8050721 and die holder 8050722. Acceptable pitch diameter for the pinion end threads is 2.6580" to 2.6738". If the pinion end threads are severely damaged, the shaft should be replaced. Check the six retainer plate bolt holes on the commutator end of the shaft. The acceptable pitch diameter is $.4050'' + .0050'' - .0000''$. If bolt holes are oversize or threads damaged beyond repair, the shaft should be replaced.

Inspect the commutator bearing seat diameter, the spacer and collar outside diameters, and the dimensions from edge of the spacer to the end of the shaft. The diameter of the bearing seat new is $3.9383'' + .0000'' - .0005''$. Minimum rebuild tolerance is 3.9375".

Outside diameter of the spacer should be within 4.494" to 4.504". Outside diameter of the collar should be within 6.240" to 6.252". The dimension from the spacer face to the end of the shaft should be within 2.713" to 2.723". This face must also be perpendicular to the bearing seat within .001" total indicator reading.

The dimension from the collar face to the end of the shaft should be within the tolerance shown in Fig. 2.

The dimension as stated should be maintained in order to obtain free movement of the bearing parts and a tight fit of the C.E. race on the shaft.

Referring to Fig. 3, inspect pinion end inner oil ring for roughness and wear. Maximum runout of oil ring face is .001".

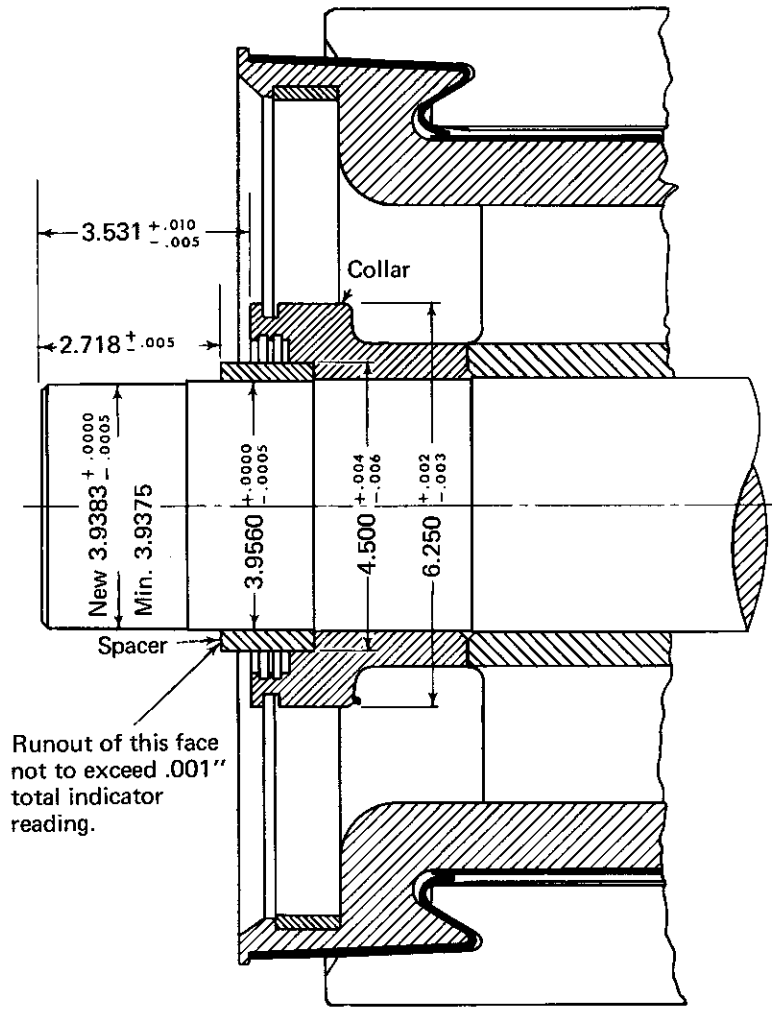
Inspect P.E. shaft diameters for size as shown in Fig. 3. Inspect bearing and pinion seat surface for damage, fretting corrosion, or roughness. The seat may be "cleaned up" by light rubbing with crocus cloth.

NOTE: Do not rub the pinion seat axially or work below the normal surface. Do not use a shaft with heavy damage on the seat.

MECHANICAL INSPECTION

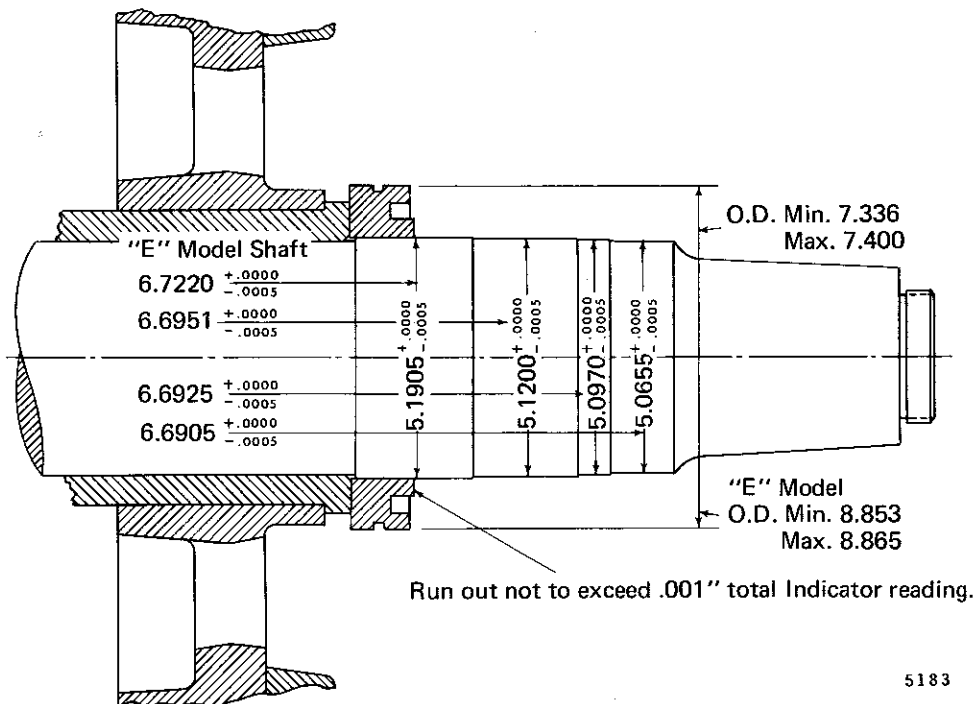
END BELL

Inspect end bell for tightness, tightening cap screws where needed. The aluminum end bell can be checked for looseness by tapping it lightly with a small mallet. If the end bell is loose, a white powder or dust will be visible as the end bell is tapped. If this happens the end bell should be removed and insulation renewed.



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Fig. 2 - Armature Shaft (C.E.)



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Fig. 3 - Armature Shaft (P.E.)

WEDGES

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

Phenolic wedges should be checked for charred or loose condition. To check for tightness, tap lightly on each wedge, with a small mallet, using the fingers to sense a loose wedge. Charred or loose wedges must be replaced.

If there is only slight evidence of loose wedges the armature should be vacuum impregnated.

STRING BAND

All varnished and painted polyester string bands or epoxy coated string bands which need replacement should be replaced with the fiberglass cord string band and Teflon covering, 8442224.

Be sure the string band and vertical edge of the commutator bars are clean and in good condition. Apply epoxy primer 8430367 to the vertical edge of the commutator bars. Then apply an adhesive film 8455335 to the string band and commutator wall where the Teflon covering will seat. Install the Teflon covering and apply pressure with a steel band or similar device. Put the armature in an oven at 300°F. for 1 hour. Remove from oven and take off steel pressure band.

TENSION BAND

Inspect for loose or damaged wire or glass bands. If the bands are cut, scuffed, cracked, wire bands have thrown solder or are loose, and the rest of the armature is satisfactory, the bands should be replaced.

When it becomes necessary to replace P.E. wire or glass bands, they must be replaced with a wire band as described in Section 7 of this M.I.

When the C.E. wire or glass band needs replacement, it must be replaced with a glass band as described in Section 7 of this M.I.

When the C.E. wire band is in good shape it must have a covering of glass tape and epoxy if it has not previously been applied.

Cleaning

1. Remove all paint and dirt from the commutator end wire band with a wire brush.
2. Lightly brush the insulation protruding from under the wire band on both sides.
3. Make certain the area to be coated is free of dirt and paint. Epoxy must have a clean bonding area.

Application Of Glass Tape And Epoxy Resin

1. Wipe commutator end wire band with Xylol.
2. Apply one turn of 1" masking tape to top of commutator riser.
3. Using kit 8260298, mix material as instructed in kit.
4. With a 2" varnish brush apply a coat of resin to the entire surface, from rear edge of commutator riser to edge of insulation under the band at the core side of the band. Coat surface of wire band as evenly as possible.

NOTE: This application should require about 1/2 of the mixed resin.

5. Apply one layer of ten mil glass tape 8136648 one half lapped to the entire coated surface ending at edge of insulation on core side of band. Tape should be pulled as tightly as possible. Hold end of tape in place with epoxy resin. Apply tape in the following manner:

- a. Begin taping next to commutator riser.
 - b. Wrap the half lapped layers across the entire area end so the last turn is even with the edge of the insulation on the core side of the band.
 - c. Apply tape as tightly as possible. Rotate armature as tape is applied.
6. Apply the remainder of the resin to the taped surface. Cover surface thoroughly, working resin into tape. To smooth out resin rotate armature while holding brush against the coated area.

When the resin application to the band is complete, the armature will have to be rotated during the time required for the resin to cure. This rotation is necessary to prevent forming uneven surfaces on the resin. The resin will cure at room temperature in 2-1/2 to 4 hours; however, this cure time can be accelerated by applying heat to the resin. The heat can be applied with infra-red lamps or by placing the armature into an oven for 20 minutes with the oven temperature set between 135°–150°C. Regardless of the heating method used, the armature must be rotated during the heating period.

MEGOHMMETER TEST

After the mechanical inspection has been completed and before any electrical inspections are made, the armature should be given an insulation resistance check using a 500 volt DC megohmmeter. If the reading is 2 megohms or less, armature should be placed in an oven for 6 hours at 110°C. to dry. Recheck armature megohm reading after cooling the armature to room temperature. If the readings are still low, the armature should be checked further to determine the cause of the low readings. In some cases the armature may have to be stripped and rewound to correct the low insulation resistance readings.

If the armature passes the preceding insulation resistance test, proceed with the following inspections.

INSULATION INSPECTION

Vacuum impregnation of the armature is not to be done until after a detailed inspection of the armature has been made.

Inspect for evidence of powdering insulation. If very slight evidence of powdering is found, it will generally be accompanied by loose wedges or wire bands. This can be reworked by rebanding, rewedging and then varnish impregnating the armature. If evidence of heavy powdering is found, the armature should be rewound.

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

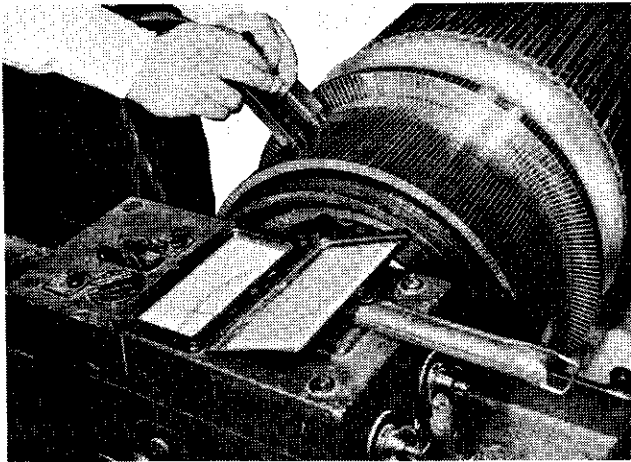
NOTE: Occasionally the armature core becomes scuffed or rubbed on the outside diameter, due to bearing failure. This type of core damage is acceptable over any portion of the core's outer diameter providing the damaged area, after clean up (edges of lamination must be clearly visible) has not been reduced more than .018".

DUCTOR TEST (LOW RESISTANCE BAR-TO-BAR TESTING)

The "Ductor" 8068118, Fig. 4, is a low resistance ohmmeter which measures resistance in micro-ohms. A range switch is provided on the ductor so the readings may be set for direct or in multiples to obtain the desired results.

There are many factors involved in bar-to-bar readings which make it difficult to assign any specific micro-ohm reading to a given armature, consequently, normal readings may vary in similar type armatures. However, all bar-to-bar readings on an individual armature should be the same. Maximum allowable limits should be plus or minus 1 point on the scale from the established normal reading of the armature being tested.

NOTE: Normal reading of the armature is established by taking a reading on approximately 20 bars. The reading most consistent can be considered the normal reading.



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Fig. 4 — Bar-To-Bar Resistance Check

It is important to keep a close watch during the test, and all bars on the commutator should be checked.

The commutator riser should not be disturbed before performing a preliminary ductor test. Removing the paint with a file or light lathe cut may temporarily correct any high resistance trouble by copper dragover between the coil leads and the riser. If this should occur, the ductor in many cases would not show a high resistance reading. In such a case, the real trouble, for example a poor solder connection, will again show up in operation, with the possible loss of the armature. It is also important to have the slots between the bars clean and free of any copper chips when making a ductor test.

The ductor test should be made in the following manner:

1. Turn on and let the ductor test meter warm up for 20 seconds.
2. Set meter on desired scale to obtain best readings. Have ductor in a level position.
3. Each test prod has two needle points: red is the potential needle and black is the current needle. Prods must be held with the red needle to inside in each hand.
4. Apply prods on adjacent commutator bars with enough pressure to penetrate surface of copper. When moving to next bar, move one prod at a time to adjacent bar, breaking contact with the black needle then the red needle.
5. Establish a "normal" reading by checking approximately 20 bars.
6. Check every bar in the commutator, allowing one point below and above as a maximum over the established normal reading. Mark bar edge to indicate any low or high readings for later correction.
7. Readings above normal indicate high resistance due to defective circuits, usually caused by poor solder joints in the commutator riser.

NOTE: Low voltage in the battery used with the ductor may cause erratic readings. Batteries should be kept charged.

Very high resistance or open circuits in the armature will cause the overload protector in the ductor to open, if so equipped. Press reset button to put ductor back in operation.

Inspect commutator necks for shifted armature leads and thrown solder at the commutator riser. A bar-to-bar resistance check should be taken and any high readings should be hand soldered with pure tin solder. If a large number of leads show high readings and lead shifting, the complete commutator riser should be resoldered. If after soldering, a bar-to-bar resistance check still shows high readings the riser should be split at the lead connection and the leads fluxed and set. Then solder the riser again. If test results

are still unsatisfactory, the armature should be stripped and rewound. Unsatisfactory readings after the second soldering usually indicate cracked armature coil straps. For rewinding see Section 7 of this Maintenance Instruction.

COMMUTATOR INSPECTION

Inspect the commutator on the armature assembly as follows:

1. Inspect commutator surfaces for standstill burns, damaged bars, high bars, raised mica, and grooving. If the commutator brush surfaces and/or riser have been damaged, they should be machined in a lathe before making further checks.
2. Check the diameter of the commutator brush surface. Condemning limit is 15-1/8". If below this limit, the commutator must be replaced.

Maximum taper of this surface shall not exceed .010"; providing the surface has not recently been machined or stoned, in that case, the maximum taper, should not exceed .005". The allowable out-of-round should not exceed .001", total indicator reading, when shaft is rotated between centers. Assembled as a motor, the runout should not exceed .003" on this surface.

NOTE: See Commutator Surface Conditions in M.I. 3900.

3. Check the width of the riser (neck), which must be wide enough to provide sufficient stock so that after final commutator machining, the width shall not be less than 5/8". If less than 5/8", the commutator must be replaced.
4. Check the riser diameter. The minimum riser diameter is 18-1/16" for D67 or later models and 17-15/16" for D57 or earlier models.

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

5. Inspect for damaged V-ring and string band. If string band is broken or burned through so the V-ring is damaged, the commutator insulation V-ring must be replaced.

VARNISH TREATMENT

After all inspection and repairs to the armature have been completed, other than final machining of the commutator and balancing of the armature, proceed with varnish treatment.

Use varnish 8417967 thinned with Xylol 8089758 to maintain viscosity at 40 to 55 seconds Ford Cup No. 4 at 21.1°C. The vacuum impregnation should be performed as follows:

1. Clean core section thoroughly with Xylol or petroleum solvent and wipe dry with a clean dry cloth.
2. Preheat armature until average core temperature stabilizes at 120°C. + 5° - 10°. Be sure oven temperature does not exceed 175°C. at any time.
3. Remove armature from oven and place in vacuum impregnation tank. Average core temperature of armature must be 105° to 120° C. when being placed in tank.
4. Apply 28" to 30" vacuum to tank for 15 minutes.
5. With vacuum still on tank, run varnish into tank to level of commutator riser. If varnish tends to boil, bleed in small amount of CO₂ until boiling stops. Do not, however, open release valve to permit entry of atmospheric air. When varnish reaches proper level, apply 30 to 40 lbs. CO₂ pressure for at least 15 minutes.
6. After 15 minutes reduce CO₂ pressure to 10 to 15 lbs. and run varnish out of vacuum tank into storage tank.

7. Open valve to atmospheric air and allow armature to drain for 25 minutes. After drain period, close valve and apply 28" to 30" vacuum for minimum of 5 minutes.
8. Remove armature from impregnation tank and wipe off P.E. shaft and end bell with solvent to remove varnish. If the varnish flowed over the riser face while in the tank, the face must be wiped clean with solvent.

NOTE: On motor armatures with the hydraulic pinion removal feature, thoroughly clean the hydraulic hole passages with solvent, then re-apply the 1/2"-20 set screw hand tight.

9. Place armature in convection oven and bake for 6 hours after the average core temperature reaches 155°C. Do not allow the oven temperature to exceed 175°C.
10. Remove the armature from the oven and while armature is still hot (50°C. ± 10°) perform a ground test at 3200 volts for 1 minute. If armature fails ground test, it will have to be stripped and rewound. See Section 7 of this M.I.

After armature has cooled, check commutator bolts for tightness if they have been loosened for any reason during repair. Bolts should be torqued to 140 ft-lbs for arch bound commutators, 275 ft-lbs for armatures with nomex "V" rings and 320 ft-lbs for armatures with mica "V" rings.

NOTE: The arch bound commutator can be identified by a groove machined into the chamfer of the spider flange.

FINAL MACHINING OF THE ARMATURE COMMUTATOR

If the pinion end inner oil ring and commutator collar and spacer were removed, it will be necessary to replace them at this time. Before applying them to the shaft, check the dimension from the end of the slot to the quill at the pinion end and from the end of the shaft to the commutator spider at the commutator end. See Fig. 5 for dimensional tolerance. If the dimensions are under size, machine spider or quill as necessary. Do not machine off the ends of the shaft. If the dimensions are oversize, add laminated spacers 8135277 for the pinion end and 8082782 for the commutator end.

NOTE: These spacers are so constructed as to be able to remove necessary amount by pulling off layers. Check the spacer size with a micrometer before applying to the shaft.

When the proper dimension is obtained, apply laminated spacer (where necessary), oil ring, collar and spacer to the shaft.

NOTE: The oil ring, collar and spacer will have to be heated before they can be assembled to the shaft. Heat parts to a temperature of 115° to 125°C. in an oil bath. Assemble spacer 8300120 so radius of inside diameter faces end of the shaft.

After assembling the parts to the shaft, place the armature in a lathe and check runout of shaft using a dial indicator. The maximum runout is not to exceed .002" total indicator reading at the pinion end bearing seat. The P.E. oil ring face should not exceed .002" total indicator reading. At the commutator end, check and machine the distance between the end of the shaft and the spacer and machine to conform to tolerance shown in Fig. 5, being careful not to cut into the shaft as spacer is machined. Indicate the spacer face just machined, total runout not to exceed .0005".

Check and machine the commutator brush surface and riser as necessary to give a good surface holding dimension, shown in Fig. 5.

UNDERCUT COMMUTATOR

Check the depth of the slots between the commutator bars. Slots should be .033" wide and between 3/64" to 5/64" deep. If these tolerances are not met, the commutator mica will have to be undercut. This can be accomplished by using an undercutting tool similar to that shown in Figs. 6 and 7, and removing the necessary mica.

After undercutting, blow off any loose copper and mica using low pressure high volume dry air.

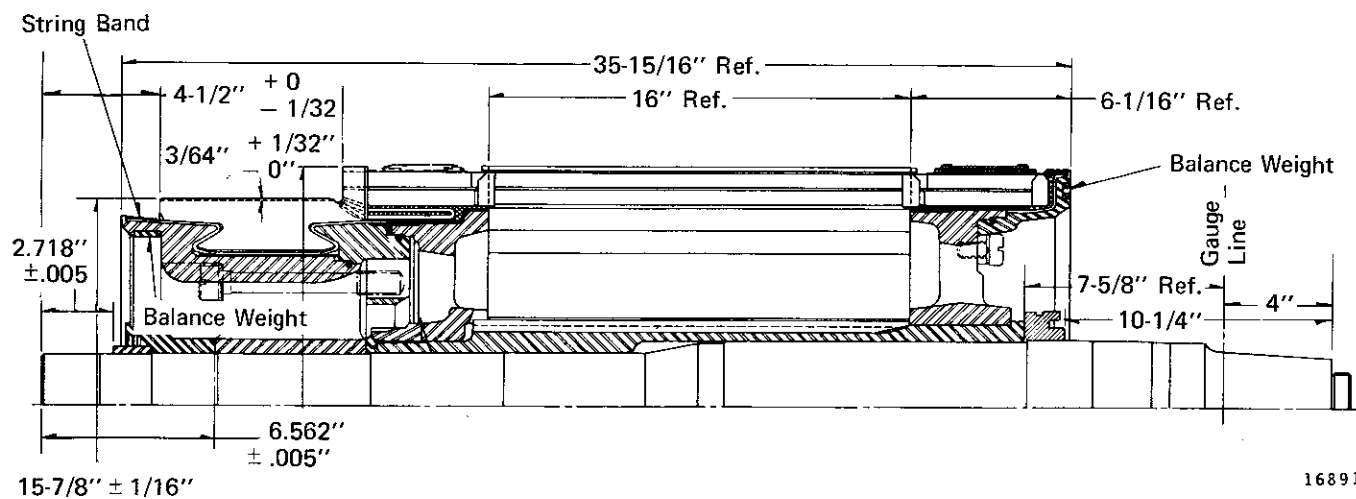
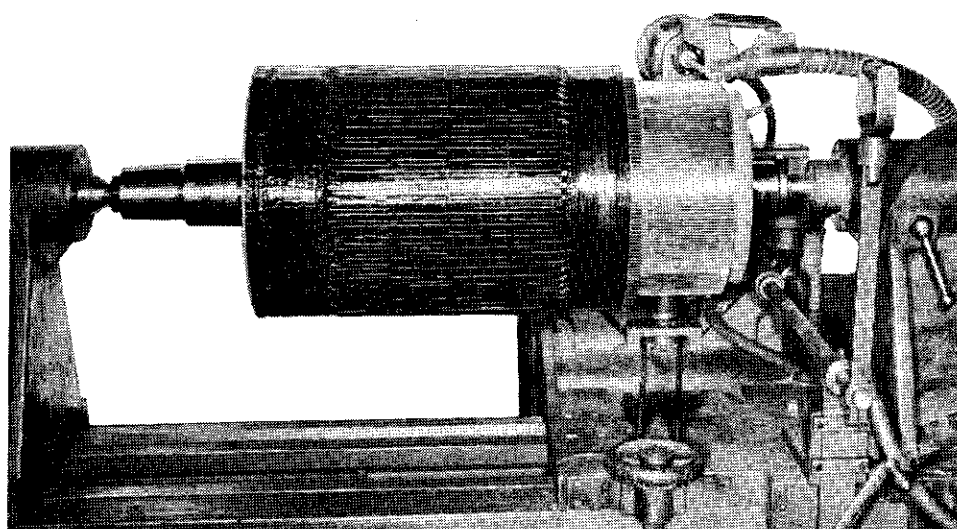
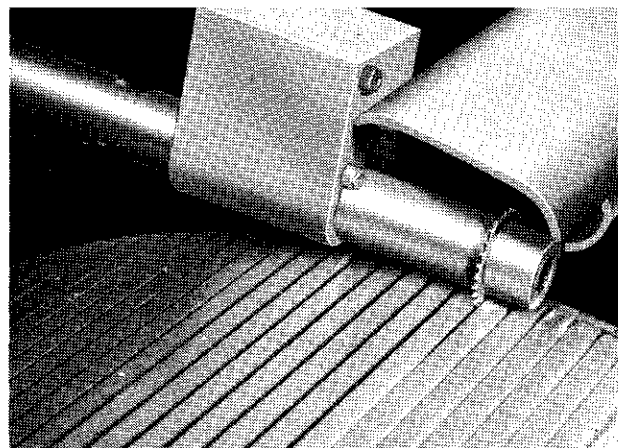


Fig. 5 — Armature Cross-Section



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Fig. 6 — Apparatus For Undercutting Mica



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Fig. 7 — Undercutting Mica

DYNAMIC BALANCE

Remove the armature from the undercutter for dynamic balancing. Dynamically balance the armature within 2 inch-ounces at 500 RPM.

NOTE: Armature must be balanced well enough so that when floated through the "critical speed" of the balancing machine, it will not deviate from true rotating motion.

Apply balancing block 8300143 at P.E. into the groove of the end bell locking in place with set screw 115321. Stake weights at end bell to prevent shifting.

Apply balance weight 8104091 at C.E. cutting off required amount and welding into place under the commutator "V" ring.

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

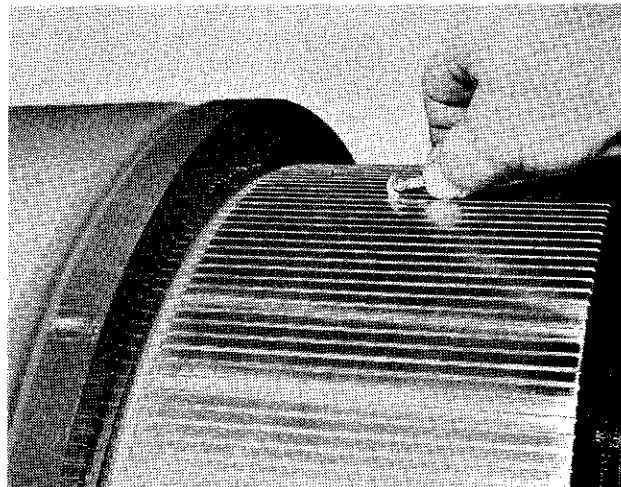
After the balance weights are in place, place the armature in a lathe to grind and polish the commutator. Grind the commutator as necessary using a fine grit stone similar to 8204167. After grinding, check the taper of the commutator. It should not exceed .005" total indicator reading.

After grinding the commutator, the edge of the bars will have to be burred to remove any dragover from grinding, see Fig. 8.

BURRING COMMUTATOR

NOTE: When burring the edge of the bars, do not cut into the ground surface of the bar with the burring tool. Just hold the burring tool at an angle of approximately 45° and pull tool in manner shown in Fig. 8, being careful not to damage the insulation over the "V" ring as the burring tool is pulled out of the slot.

After the commutator bars have been properly burred, hand polish the surface of the commutator using 0/6 220 grit sandpaper, moving sandpaper around the surface. Do not polish back and forth between the riser and the "V" ring. Blow off commutator using dry air to remove any copper and sandpaper dust.



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Fig. 8 — Removing Burrs From Commutator Bars

MAINTENANCE DATA

SPECIFICATIONS

Commutator Wear Limits

Minimum Diameter	15-1/8"
Mica Groove Depth	3/64" to 5/64"
Minimum Riser Neck Width	5/8"
Minimum Riser Neck Diameter	
D57 or earlier	17-15/16"
D67 or later	18-1/16"