ELECTRO-MOTIVE

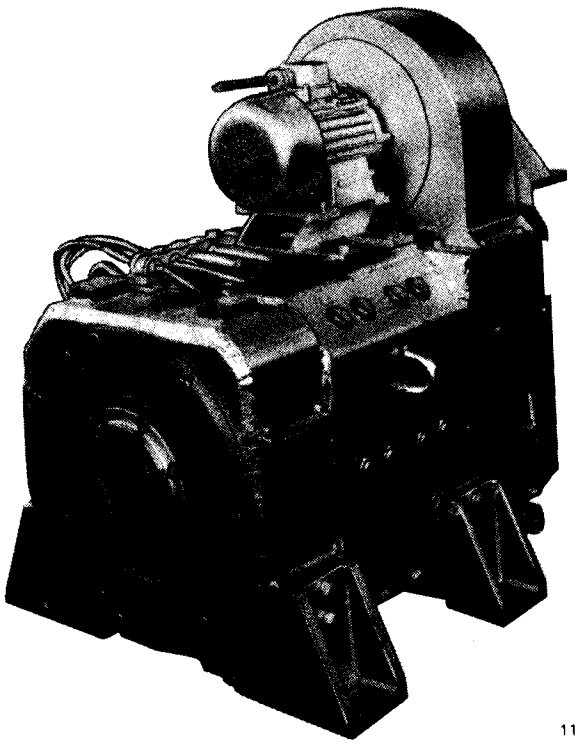
M.I. 3903
*Rev. D

# MAINTENANCE INSTRUCTION

# GENERAL MAINTENANCE INDUSTRIAL MOTORS AND GENERATORS D39, D49, D59, D69, D79, M79, G79, M89, G89

## INTRODUCTION

This Maintenance Instruction contains general or "running" maintenance for industrial motors and generators, Fig. 1. The data will apply to all motor and generator models unless specifically identified.



11432

Fig.1 – Motor/Generator Assembly

The extent of maintenance required is determined by the operation and service to which the motor or generator is subjected. Refer to recommended maintenance intervals specified in the applicable Scheduled Maintenance Program.

## DESCRIPTION

Effective in mid 1981, most "79" and "89" model machines will have a new model code. The nomenclature used to describe the model is changed to more accurately describe the configuration of the model. The letter "D" is replaced by either a letter "M", which designates a series wound motor, or a letter "G", which designates a separately excited, shunt wound motor, which can be used as a generator. A series of letters after the "79" or "89" is used to describe the physical configuration of the motor such as the armature shaft type, blower or junction box application, and external accessories.

Off-highway vehicles are not included in this coding system because the motors are highly specialized with special frames, bearing arrangements, and armature shafts. The off-highway vehicle motors are coded as follows:

| | |
|---|---|
| Unit Rig & Equipment Company Off-Highway Vehicle Motor | M89URT |
| Wabco Construction Equipment Division Off-Highway Vehicle Motor | M89WTM |

The new model code is as follows:

*This bulletin is revised and supersedes previous issues of M.I. 3903, M.I. 3905, and M.I. 3906.

# MODEL CODE

| | |
|---|---|
| First Letter Indicates Machine Type | M =Motor (Series)<br>G =Generator (Separately Excited) |
| Model Number | 79 Or 89 |
| Second Letter Indicates Armature Shaft Type | A =Standard<br>B =Through Shaft – Tapered Output – Commutator End<br>C =Through Shaft – Splined Output – Commutator End, Shaft With Through Hole<br>D =Thrust Bearing – Allows Vertical Mounting |
| Third Letter Indicates Blower/Junction Box Application | A =No Blower Or Junction Box External Leads/Clasp Connector<br>B =10 HP, 440 V Blower External Leads/Clasp Connector<br>C =10 HP, 600 V Blower External Leads/Clasp Connector<br>D =7-1/2 HP, 440 V Blower External Leads/Clasp Connector<br>E =7-1/2 HP, 600 V Blower External Leads/Clasp Connector<br>J =Junction Box Only<br>K =10 HP, 440 V Blower Junction Box<br>L =10 HP, 600 V Blower Junction Box<br>M =7-1/2 HP, 440 V Blower Junction Box<br>N =7-1/2 HP, 600 V Blower Junction Box |
| Fourth Letter Indicates Accessories | A =No Accessories Applied<br>B =Louvers, Louvered Roof, Rodent Screen, Heater, Mounting Feet, Drive Flange, Guard |

An example of the model code:

| Motor | 79 | Standard Armature | 10 HP, 440 V Blower With External Leads | No Accessories Applied | |
|---|---|---|---|---|---|
| M | 79 | A | B | A | = M79ABA |

Other than Model "79" and "89" shaft and bearing configuration differences, all of the models are similar in appearance and are the same general size, The differences are internal improvements to later models which have progressed from the original Model D39 to improve service life and to increase motor or generator output.

The later model motors or generators are similar to Model D39 with the following differences:

D49 — Increased copper size in stator field.

D59 — Application of a modified silicone varnish to armature coils to improve heat resistance, improved commutator seasoning, and the use of constant pressure brush holders.

D69 — New armature coil construction to reduce temperature and moisture.

New type brush holders with longer brushes for extended brush life.

**NOTE**

The longer brushes cannot be used on Models D39, D49, or D59 unless brush holders are changed or modified.

D79, M79, G79 — A thinner armature insulation (polyimide film) which allows an approximate 20% increase in armature coil copper.

TIG (tungsten inert gas) welded joint between armature coil and commutator to ensure a more positive electrical connection.

Nomex V-rings in the commutator to improve commutator stability and performance.

M89, G89 — Increased copper size in stator main field and interpole coils.

Increased copper size and transposed conductors (at center of armature core) in the armature coils.

Change in stator coil air baffles because of increase in the main field and interpole coil sizes.

All motors of the same type are interchangeable as an assembly. The generator power limit must be adjusted for the lower motor or generator rating. All generators of the same type are also interchangeable as an assembly, but due to differences in field resistance, the generator maximum no load voltage setting must be made.

On most motors and generators cooling air is supplied by an AC blower motor, mounted on top of the unit.

## CLEANING

Both the exterior and interior of the motor or generator should be kept clean and free of dust, dirt, oil, and water which are likely to have a detrimental effect on insulation and performance.

As often as conditions warrant, the motor or generator should be blown out with low pressure air. Avoid excessive air pressure which could cause damage to the insulation.

Clean, bound-edge, lintless wiping cloths should be used as necessary to remove oil, grease, and accumulations of dirt.

In cases where air and dry wiping cloths prove incapable of removing caked grease and dirt, a stiff brush and soft wood or fibre scrapers may be used. In severe cases it may be necessary to dampen a cloth in solvent such as Stoddards Solvent to loosen and remove imbedded deposits. Every precaution should be taken to keep the solvent off the commutator and copper parts.

Chlorinated hydrocarbon type cleaning solvents are not recommended for use on the equipment because of the possibility of insulation damage. This type solvent can deteriorate semi-cured silicone rubber and can swell ethylene-propylene rubber, natural rubber, neoprene, and hypalon during extended soaking periods. The vapor state at 70° C (160° F) attacks uncured silicone rubber within 20 minutes. The vapors of these solvents also have an adverse effect on commutation. Special care is also necessary to avoid subjecting the polyester glass insulated brush holder studs to alkaline type cleaning solutions.

**CAUTION**

Adequate ventilation and safety precautions are necessary when handling inflammable fluids such as Stoddards Solvent which has a flash point of 46° C (115° F).

# COMMUTATOR BRUSH HOLDERS

All motors or generators since the D59 are equipped with constant pressure spring cell brush holders. The motors or generators since the D69 use a brush holder which will accept a longer brush. The longer brush extends the period between brush changeouts. If the longer brush is desired for the Model D59, a new style brush holder must be installed. The D39 and D49 model brush holders can be modified to use the constant pressure spring cell, but if the longer brush is desired, the new style brush holder must be installed. All D39 and D49 models rebuilt at the factory are equipped with the latest model brush holder.

## BRUSH HOLDER INSPECTION AND REPAIR

### CARBONWAYS (BRUSH SLOTS)

Check carbonways for wear with gauge. Refer to Service Data for gauge part number. Each carbonway should be between 15.95 mm to 16.13 mm (.628" to .635").

**NOTE**

Coil spring type (adjustable) brush holder 8330411 carbonways cannot be repaired by peening and filing because of the die cast material of the brush holder. Coil spring type brush holders with worn brush slots must be replaced with new brush holders.

On constant pressure type brush holders, when carbonways are worn or distorted beyond acceptable limits and the wear is not too great, it is possible to rework the slots. Insert the gauge into the slot and gently peen the outer surface of the slot to close it in. By peening and filing, carbon-to-slot clearance can be restored.

### CONSTANT PRESSURE SPRING TYPE BRUSH HOLDER

Constant pressure spring type brush holder, Fig. 2, spring pressure is pre-set and cannot be adjusted. However, if there is reason to suspect possible loss of spring pressure, such as that caused by the heat of a commutator flashover, the spring pressure should be checked. It is difficult to check brush holder spring pressure accurately with the brush holder in place, and it is recommended that the brush holders be removed. Refer to Spring Cell Removal procedure which follows.

The spring pressure of a new spring with the spring cell in the brush holder should be within 1.8 to 2.3 kg (4 to 5 lbs) at each of the three springs as measured with a spring tension scale at the position shown in Fig. 3.

The spring pressure of a used spring should be a minimum of 1.6 kg (3.5 lbs) when checked at the position shown in Fig. 3.

If the spring pressure of a new or used spring cell, with the spring cell in the brush holder, is not within tolerance, remove the spring cell from the brush holder and check as shown in Fig. 4. If the spring is not within tolerance, replace the spring cell with a new spring cell.

To ensure proper tightness of brush holders and connections, the following dry torque values should be applied;

7/8"-9 brush holder block bolt - 203 to 217 N·m (150 to 160 ft-lbs).

1/2"-13 brush holder cable to brush holder bolt - 95 to 102 N·m (70 to 75 ft-lbs).

5/16"-18 brush holder shunt screw - 15 to 20 N·m (10 to 15 ft-lbs).

### SPRING CELL REMOVAL

When inspection indicates it is necessary to remove the spring cell assemblies from the brush holder, Fig. 2, perform the following.

1. Place brush holder fingers in "cocked" position.

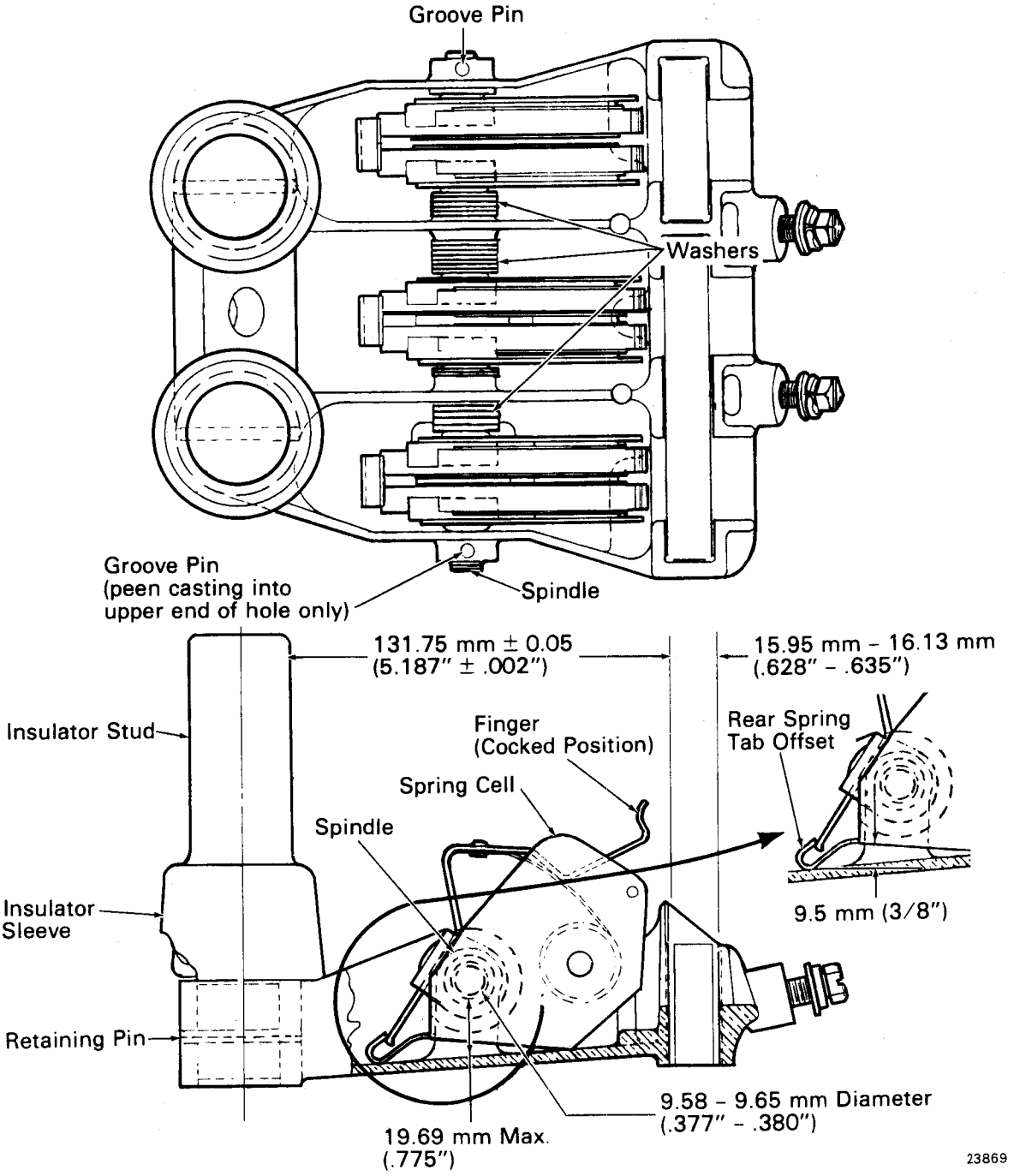



Fig.2 - Constant Pressure Spring Type
Brush Holder Assembly

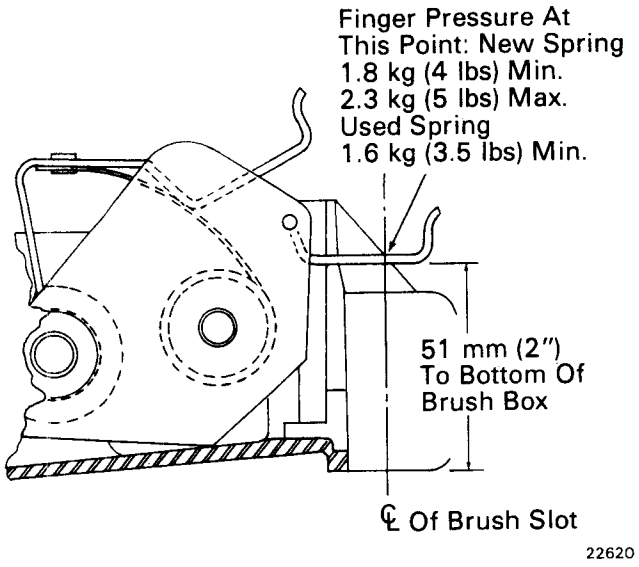



Fig.3 – Measuring Constant Pressure Spring Type Brush Finger Pressure (Spring Cell In Place)

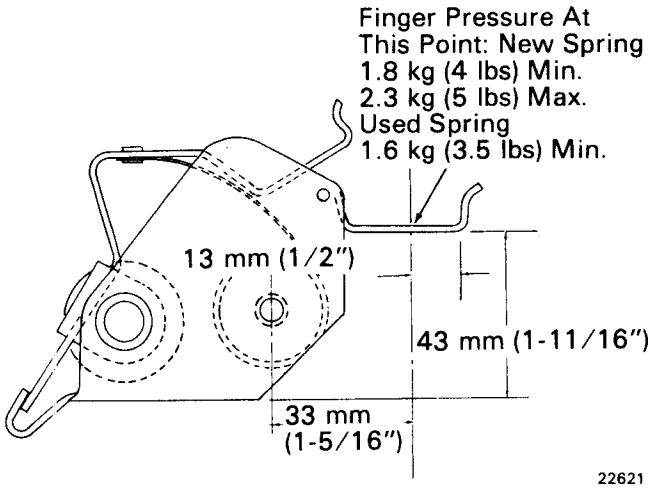



Fig.4 – Measuring Constant Pressure Spring Type Brush Holder Finger Pressure (Spring Cell Removed)

2. Pry lower end of each groove pin (visible in the holes directly below and at each end of the spindle) slightly upward until pin protrudes from the top of the holder. Pull pin out of hole.

3. Drive spindle out of brush holder to free spring cell assemblies.

## SPRING CELL REPLACEMENT

Before replacing spring cell assemblies, inspect brush holder casting and insulator pins. Replace any defective parts with new parts. Repair all defects.

1. Insert the spindle in the spindle hole with the spindle pushed up against the top of the hole. Check the distance from the bottom of the spindle to the inside surface of the bottom web of the brush holder casting, as shown in Fig. 2. If this dimension is greater than 19.69 mm (.775") or if the hole is more than 51 mm (.020") oversize, the hole must be plugged and relocated.

2. Check rear spring tab to ensure that offset of tab is 9.5 mm (3/8"), Fig. 2. Bend rear spring tab as required. Place brush holder fingers in "cocked" position.

3. Place cell assembly in brush holder spring pocket with fingers centered in slot "A" as shown in Fig. 5.

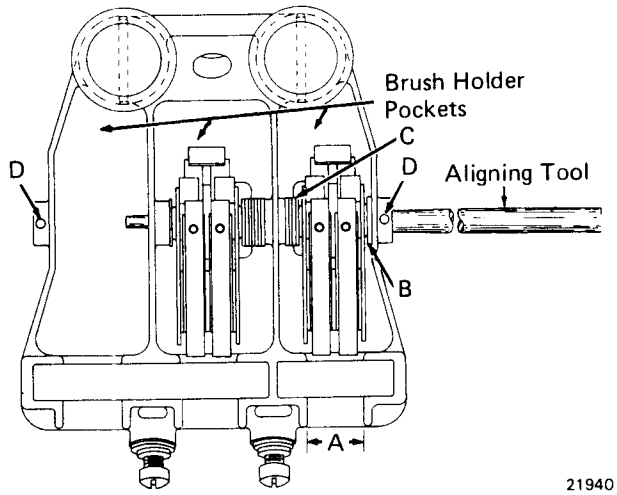



Fig.5 – Installing Spring Cell In Brush Holder

4. Insert aligning tool through spindle hole and spring cell. Add necessary washers at areas "B" and "C" as shown in Fig. 5. Check alignment of spring cell with finger slot "A" and, if cell is out of line, remove alignment tool and reassemble.

5. Follow same procedure with center and left-hand cells. Use as many washers in the lineup as possible. After each cell is assembled, recheck the alignment with finger slot "A."

6. When all cells have been installed, drive the aligning tool out of the assembly with the spindle. Continue to drive the spindle through until the spindle is centered in the brush holder.

7. If old spindle is used, the two 3.2 mm (1/8") diameter holes in the ends, "D" of Fig. 5, should be aligned with the matching holes of the brush holder. If new spindle is used, drill two 3.2 mm

(1/8″) diameter holes at area "D" of Fig. 5. Insert groove pins in each hole at area "D." Peen casting lightly into each hole to lock pins.

8. Ensure each spring cell is tight in the brush holder. If cells are properly installed, the cells will be held firmly at contact points "E" and "F" of Fig. 6. If required, adjust rear spring tab so that spring cell is anchored tightly in assembly at points "E" and "F" when spindle "G" is driven in place. Points "E" and "F" must have definite contact with holder.

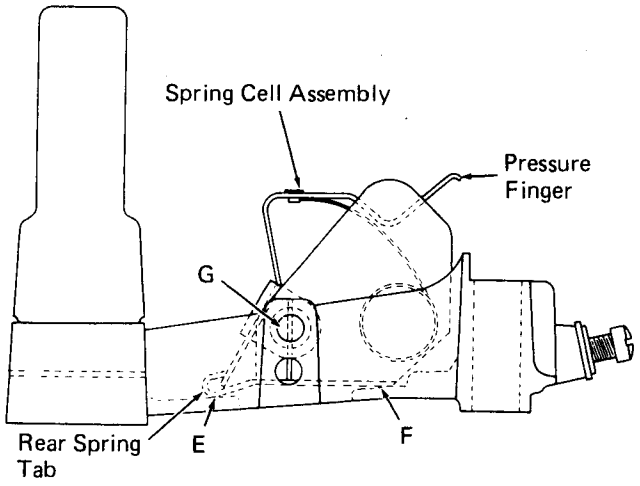



Fig.6 - Position Of Spring Cell Assembly In Holder

9. After assembly, release brush holder fingers from "cocked" position to prevent handling damage and to prepare assembly for installation.

## COIL SPRING TYPE (ADJUSTABLE) BRUSH HOLDER

New or replacement brush holder springs for coil spring type brush holders should be set for an initial pressure of 4 to 5 kg (9 to 11 lbs) as measured with a spring tension scale with pressure spring lifted 3 mm (1/8″) above the top inside edge of the brush box as shown in Fig. 7. It is difficult to check brush holder spring pressure accurately with the brush holder in place and it is recommended that the brush holders be removed. Since new brush holder springs lose pressure due to aging in the first few weeks of operation, reset the spring pressure as necessary. After one adjustment, the springs should retain their pressure.

The minimum allowable pressure on a completely worn brush is 3 kg (7 lbs). Thus spring pressure should always be set high enough (4 to 5 kg [9 to 11 lbs]) to compensate for loss of pressure that results as the brush wears.

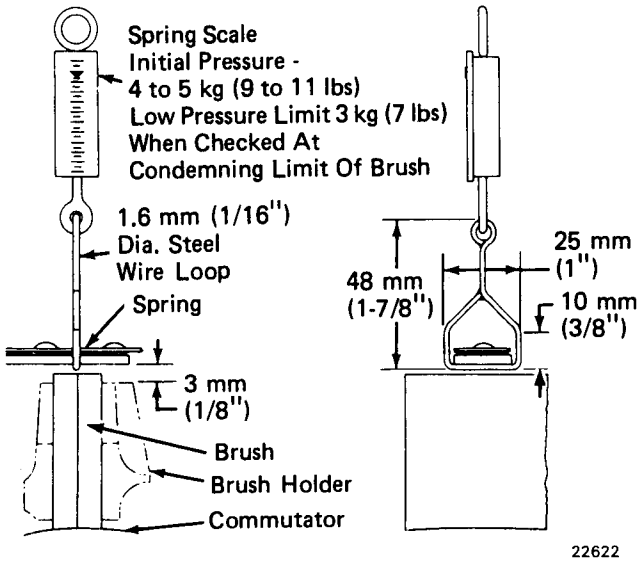



Fig.7 - Measuring Coil Spring Brush Holder Finger Pressure

Spring tension can be regulated by removing the cotter pin locking the thimble to spindle and turning the thimble and the spindle. The adjusting collar on the thimble can be set every half notch using alternately two cotter pin holes in the spindle, Fig. 8. This will allow a variation of tension from 0.57 to 0.68 kg (1-1/4 to 1-1/2 lbs) for each half notch.

The complete brush holder should be checked to ensure the mounting is secure and the cable and shunt connections are tight. The brush holder should be checked and adjusted if necessary to maintain a dimension of 3 mm to 5 mm (1/8″ to 3/16″) between the bottom of the carbonway and the commutator surface.

To ensure proper tightness of brush holders and connections, the following dry torque values should be applied;

7/8″-9 brush holder block bolt - 203 to 217 N·m (150 to 160 ft-lbs).

1/2″-13 brush holder cable to brush holder bolt - 95 to 102 N·m (70 to 75 ft-lbs).

5/16″-18 brush holder shunt screw - 15 to 20 N·m (10 to 15 ft-lbs).

## SPINDLE AND THIMBLE REMOVAL

When inspection indicates it is necessary to remove the spindle to replace the thimble or brush holder finger, Fig. 8, perform the following.

1. Pry lower end of each groove pin slightly upward until pin protrudes from the top of the

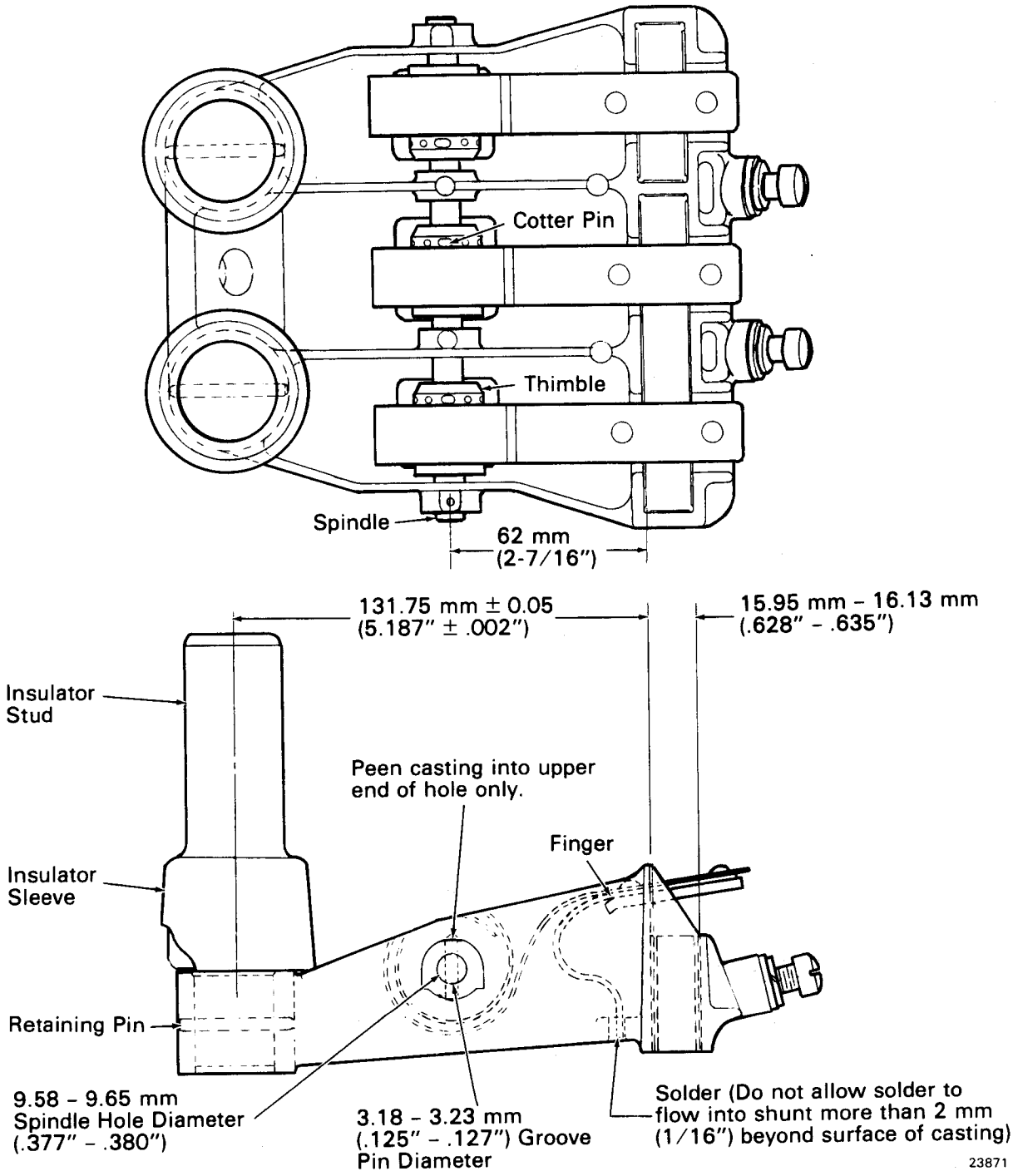



Fig.8 - Coil Spring Type Brush Holder

holder. Pull pin out of hole. It may be necessary to use a drift and hammer to drive pin out. If a drift is used to drive out pin, use care not to damage the reamed hole. Ensure drift is smaller than reamed hole.

2. Remove cotter pins holding the thimbles. Hold thimble to prevent it from turning while cotter pin is removed. Insert a small drift into one of the adjusting holes in the thimble. Hold the drift firmly as the finger spring is under tension.

3. Release the spring tension on the thimble by removing the drift pin after the cotter pin is removed. The spindle can then be driven out of the brush holder body.

4. If the spring, shunt, and thimble assembly are to be removed, heat the soldered end of the shunt with a soldering iron. The spring, shunt, and thimble assembly can then be removed.

5. Inspect all component parts for wear and damage. Replace any defective parts with new parts.

6. Inspect spindle to spindle hole clearance. Maximum clearance of 0.51 mm (.020″) is acceptable.

   If clearance is greater than 0.51 mm (.020″), inspect spindle. If spindle has cracks or has wear in excess of 0.25 mm (.010″), replace spindle with a new part. New spindle measures 9.462 mm - 9.525 mm (.3725″ - .3750″).

   If spindle is acceptable, repair spindle hole as follows:

   a. Ream or drill worn spindle hole to 12.77 mm to 12.88 mm (.503″ to .507″) diameter.

   b. Clean and flux the drilled holes and plugs to be used. Refer to Service Data for plug part number.

   c. Insert plug in drilled hole and silver braze in place. Use care not to overheat and warp brush holder during brazing.

   d. Clean in hot water.

   e. Redrill the holes to 9.35 mm (.368″) maintaining the 61.9 mm (2-7/16″) dimensions.

   f. Ream the 9.35 mm (.368″) drilled holes to 9.57 mm - 9.65 mm (.377″ - .380″).

## SPRING SHUNTS

Inspect brush holder spring shunts for wear and for condition of soldered joint at brush holder.

When shunt and/or tip shows excessive wear, replace shut and tip assembly. If only slight wear on tip is found, shunt surface may be cleaned by filing.

Resolder shunt connection at brush holder with 63-37 solder or with pure tin solder.

After the shunts have been soldered in place, reassemble the thimble and spindle assembly to brush holder. Install two groove pins at both ends of the spindle to anchor spindle to brush holder. Stake upper ends of the pin holes.

**NOTE**

When the groove pin holes are oversize so that the pin is loose in the hole, rework the hole by filling the hole with silfos brazing alloy (do not overheat brush holder) and redrill to drawing size, Fig. 8.

## CONVERTING COIL SPRING BRUSH HOLDER TO CONSTANT PRESSURE BRUSH HOLDER

Convert adjustable type coil spring brush holder to constant pressure brush holder with a conversion kit as follows:

1. Dismantle brush holder spindle, thimbles, and springs and thoroughly clean and inspect brush holder casting and insulator pins. Replace any defective parts with new parts. Repair all defects.

**NOTE**

In Step 2, do not remove the oblong boss from rear of brush holder casting 8310010. Ensure that this surface is reasonably parallel with the casting surface.

2. From spring cell pockets, remove all raised numbers, letters, trade marks or bosses which will not allow the spring cell to seat firmly.

3. Insert the spindle in the spindle hole and push spindle up against top of hole. Check the distance from the bottom of the spindle to the inside surface of the bottom web of the brush holder casting. If this dimension is 0.51 mm (0.020″) greater than dimension shown in Fig. 2, perform Step 6 of Spindle And Thimble Removal.

**NOTE**

Spindle 8081883 may be reused if in good condition, but it is recommended that the new type spindle 8296216 is used.

4. The rear tab of each new spring cell which is furnished with the conversion kit is correctly adjusted for a 9.53 mm (3/8″) offset as shown in Fig. 2. If spring cell is being reapplied, make certain that this dimension is correct before applying the cell to the brush holder.

5. Place cell "fingers" in cocked position as shown in Fig. 2 when assembling cell to holder.

6. Center a spring cell in right-hand pocket and align with finger slot "A" as shown in Fig. 9.

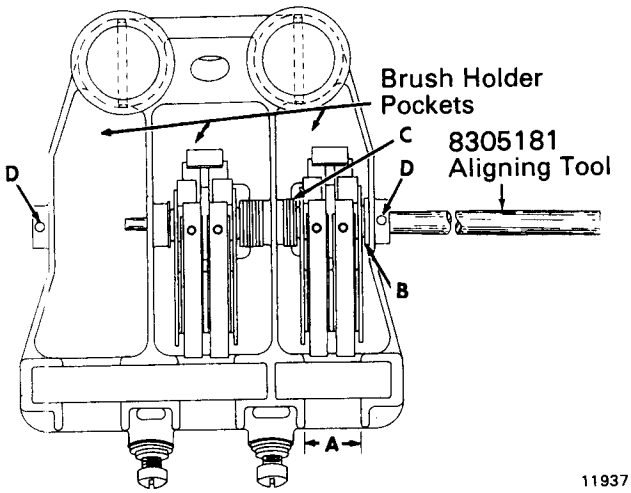



Fig.9 - Installing Constant Pressure Cell In Brush Holder

7. Insert aligning tool through spindle hole and spring cell. Add necessary washers at areas "B" and "C" as shown in Fig. 9. Check alignment of spring cell with finger slot "A" and if cell is out of line, remove alignment tool and reassemble.

8. Follow same procedure with center and left-hand cells. Use as many washers in the lineup as possible. After each cell is assembled, recheck the alignment with finger slot "A."

9. When all cells have been installed, drive the aligning tool out of the assembly with the spindle. Continue to drive the spindle through until the spindle is centered in the brush holder.

10. Drill two 3.2 mm (1/8") diameter holes at area "D," Fig. 9. Insert groove pins furnished with the conversion kit. Peen the holes to hold the pins. Ensure spring cell is tight in the brush holder.

11. After assembly, release spring cell fingers from cocked position to prevent handling damage and to prepare assembly for installation.

## BRUSH HOLDER INSULATOR STUD

Brush holder insulator studs should be kept clean and free of defects. The polyester insulated type insulator studs, Fig. 10, are unusually resistant to flashover damage. If flashover damage should occur, the insulator studs usually can be restored to satisfactory condition by polishing them with fine sandpaper. Polyester glass material should never be subjected to alkaline cleaning solutions.

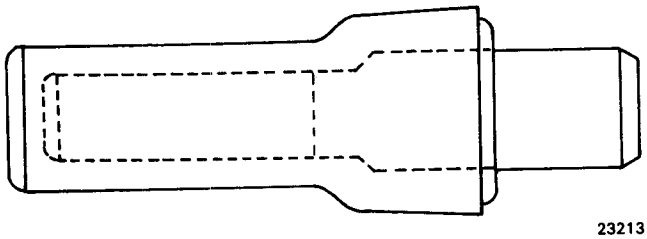



Fig.10 - Polyester Brush Holder Insulator Stud

**NOTE**

Early model brush holder insulator studs were insulated with porcelain and should be replaced with the polyester insulated studs. Polyester is more durable and does not become permanently carbon tracked.

Brush holder insulator studs have a silicone rubber insulated sleeve over the base of the studs, Fig. 11. When replacing or reconditioning brush holder assemblies, ensure insulated sleeves are in place.

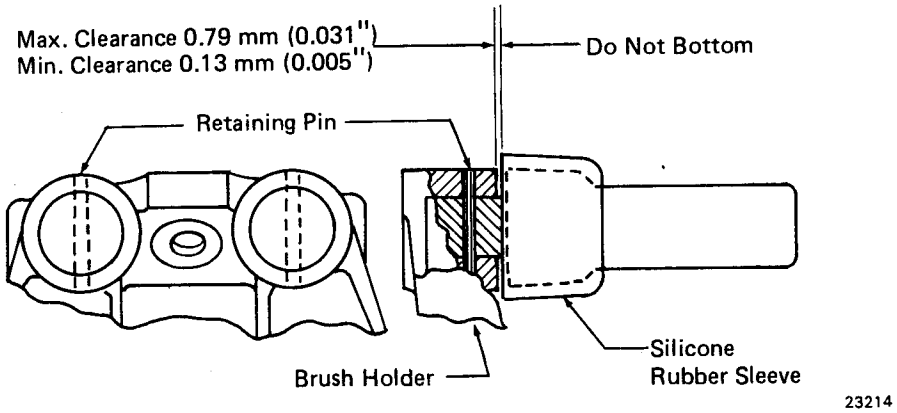



Fig.11 - Brush Holder Insulator Stud Installation

Replacement polyester glass insulated studs are available in the following sizes:

Standard size - 8159003

To be used in new brush holders or when stud holes are within 25.235 mm ± 0.013 mm (.9935″ ± .0005″).

0.05 mm (.002″) Oversize - 8209068

0.20 mm (.008″) Oversize - 8219773

For stud holes which have had a standard size pressed out.

The following studs can be used for extensively scored stud holes which have been reamed out.

0.79 mm (.031″) Oversize - 8209069

0.84 mm (.033″) Oversize - 8222653

1.57 mm (.062″) Oversize - 8222652

1.65 mm (.065″) Oversize - 8222654

The oversize studs may be identified by the number 2, 8, 31, 33, 62, or 65 stamped on the bottom of the stud. The number is in reference to the amount oversize in thousandths of an inch. For example, the number 2 identifies the 0.05 mm (.002″) oversize stud. The number 65 identifies the 1.65 mm (.065″) oversize stud.

### INSULATOR STUD REPLACEMENT

A sleeve-type tool made of half-hard brass, Fig. 12, should be used for pressing the studs into the brush holder.

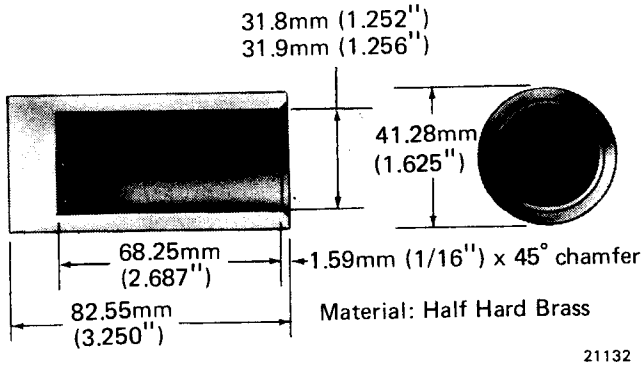



Fig.12 - Insulator Stud Installation Tool

To replace the brush holder insulator studs, perform the following procedure:

1. Press out brush holder insulator stud, shearing retaining pin.
2. Clean up stud holes of brush holder, if required.
3. Select proper oversize stud. Ensure that 0.05 mm ± 0.025 mm (.002″ ± .001″) press fit is obtained. Press in stud using sleeve-type tool, Fig. 12. Clearance between the stud shoulder and brush holder must be maintained to insure the insulation does not get damaged against the brush holder.
4. Drill and pin brush holder and stud. Use a No. 23 drill, (.1540″), and refer to Service Data for pin part number. Peen over hole on both ends after installing pin.

## COMMUTATOR BRUSHES

The D79, M79, M89, G79, and G89 machines are equipped with a three-wafer resilient pad brush. Three of these three-wafer brushes are used in each of the four brush holder assemblies. The brushes must move freely in the brush holder and not be restricted with dirt or carbon. This may be checked by lifting the brush pressure spring and raising and lowering the brushes. The constant pressure brush holder springs must be raised by hand and placed in a "cocked" position. The coil spring brush holder springs may be lifted with the use of a lifter as shown in Fig. 13.

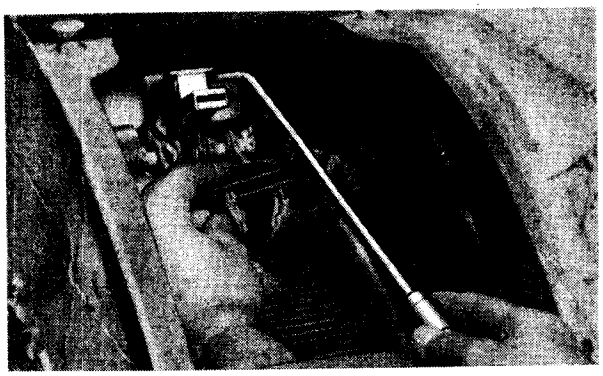



Fig.13 - Brush Inspection

Carbonways must be smooth and brushes must fit closely so they will not chatter. Brush holders with carbonways worn enough to permit brush chatter

should be replaced with new brush holders. Carefully lower the brush pressure spring over the brush to avoid snapping which is likely to cause the brush to chip.

Brushes should be carefully inspected and replaced with new brushes if chipped, broken, or worn to the condemning limit. The brush wear limit is determined by measuring the height of the brush pressure spring above the brush holder. If the spring is 3 mm (1/8") from contacting the brush holder as shown in Fig.14, the brush should be replaced with a new brush.

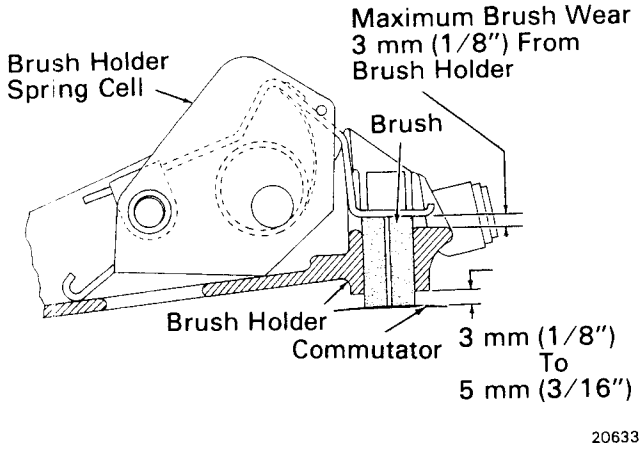



Fig.14 - Measuring Brush Wear

Brushes may be replaced individually as they wear to condemning limit. Replacement brushes should be of the same time and grade as the other brushes. Mixing brushes in the same motor can be detrimental to successful operation.

Brush shunts should not be twisted or braided. The shunt connection to the brush holder should be secure. Brushes should be replaced if shunts are broken or where tamped shunt connection to the brush is loose.

# COMMUTATOR

The commutator is a vital area on the motor or generator. It should be kept in the best condition possible. Inspections should be made at frequent intervals to ensure detection of surface faults before loss of service or before repairs become necessary. Such conditions as film stripping, burned bars, high or low bars, high mica, or flat spots become more serious with time. When a defect is found, determine the cause and correct as soon as possible.

# CREEPAGE SURFACES

The creepage area on units equipped with a covering over the string band, Fig. 15, and TIG (tungsten inert gas) welded commutator terminations should be thoroughly cleaned with alcohol to remove all traces of carbon.

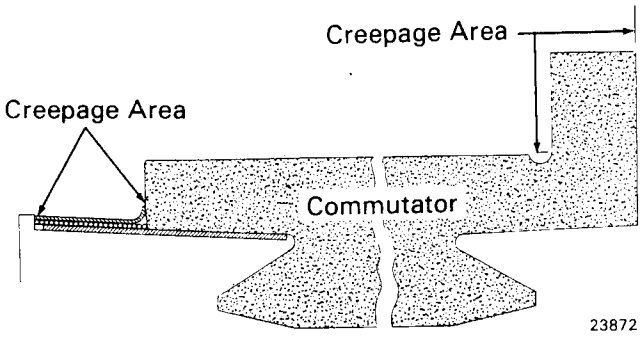



Fig.15 - Creepage Areas On Commutator With String Band Covering And TIG Welded Terminations

The creepage areas on units which have the string band area coated with epoxy or red enamel and soldered commutator terminations, Fig. 16, should be cleaned and repainted with red air drying enamel as follows:

1. Clean surfaces thoroughly with alcohol. Remove any trace of carbon.

**NOTE**

Red enamel can be applied over polyester surfaces if the surface has been damaged.

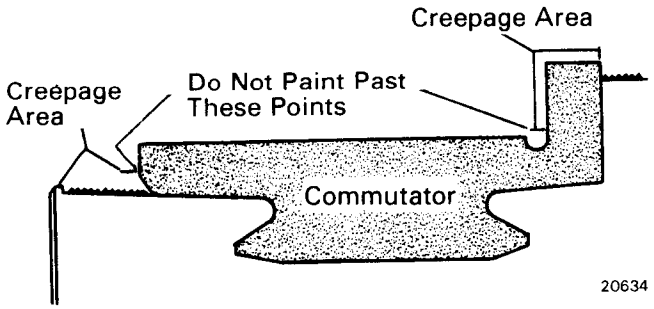



Fig.16 - Creepage Areas On Commutator With String Band And Soldered Terminations

2. Using a clean brush, apply red insulating enamel carefully to the creepage surfaces. Make as thin a coat as possible applying the enamel evenly leaving no dabs or overlapping areas.

The enamel will generally be of the proper consistency if the cover on the container has been kept tight. If thinning is necessary, use mineral spirits sparingly.

3. Take care to avoid getting enamel into commutator slots or the relief at the bottom of the commutator neck.

4. Wait until enamel is dry before running motor.

**NOTE**

Do not apply enamel over carbonized or charred insulation. If the insulation cannot be cleaned up satisfactorily as outlined above, the motor should be removed for more permanent repairs.

## COMMUTATOR SURFACE CONDITIONS

Frayed brush shunts, highly polished brush to brush box contact surfaces, excessively worn brush pressure arms, broken pressure springs, and rapid brush wear are indications of more than normal brush movement within the brush box and the cause should be determined. With few exceptions, the cause will be found to be commutator surface irregularities. The constant monitoring of the brush problems mentioned above is the best and easiest method of determining when a commutator should be ground.

Road seasoning (repeated heating and cooling of the commutator), standstill burns, and overspeed can cause some slight bar movement to occur. This bar movement, depending on the amount, the number, and location with respect to each other, could trigger conditions detrimental to both the commutator and brushes. A commutator having certain irregularities in profile could operate satisfactorily at lower locomotive speeds, however, when operated at higher speeds, the problems of flashover, brush breakage, and frayed brush shunts may develop. A very rough commutator would have these same conditions occurring at lower speeds.

A rough commutator may be apparent. If in doubt, the condition of the surface can be determined with the use of a dial indicator attached to the motor so the plunger rides on the commutator surface. Be sure indicator is on one of the brush tracks. Rotate the armature slowly and carefully observe the readings. By merely noting the minimum and maximum readings, a true picture of the commutator surface will not be obtained. The 0.08 mm (.003″) runout tolerance (for new or rebuild motors) is not applicable as a measurement of commutator irregularity as the problem of irregularity is not one of machining tolerances but of bar to bar movement. An example of this would be to have readings around the commutator that give a total variation of 0.05 mm (.002″), however, hidden within the 0.05 mm (.002″) variation are six low areas, each spanning one or more bars. This commutator would cause the brushes to bounce with resultant damage. A commutator having a total variation of 0.10 mm (.004″) with the minimum and maximum readings 180° apart is an acceptable commutator whereas the first example, 0.05 mm (.002″) variation with several low areas, is not acceptable even though the total variation is much less. It is difficult to give a number value which would determine when a commutator should be ground. The values obtained by dial indicator must be evaluated with respect to the performance of the motor (brush problems, flashovers, etc.) and a certain amount of personal judgement must be used. A useful rule of thumb is that any condition worse than 0.05 mm (.002″) in a six (6) bar span calls for grinding the commutator.

Resurfacing the commutator by turning in a lathe, or use of a grinder and grinder adapter, is the only correction recommended for a rough commutator. Hand stoning is definitely not recommended.

## COMMUTATOR GRINDER MAINTENANCE

In order to produce an acceptable commutator surface finish, it is imperative that the jig stoning fixture be maintained in good condition. The use of a poorly maintained or incorrectly adjusted grinder will result in perpetuating the surface irregularities. Refer to Fig. 17 and check the grinder as follows:

There can be no abnormal movement, however slight between the grinder cross-slide and the grinder frame or between the down-feed slide and the cross-slide. The movement can be detected by placing a fingertip on the parting of the two pieces and attempting to move either one of the pieces in all directions other than the normal direction of travel.

The travel of the cross-slide should be smooth with no binding, jerking, or tightness during the full travel from end to end. Any binding or tightness in the cross-slide travel is usually the result of one or more of the four Allen screws being incorrectly adjusted. Jerky movement of the cross-slide travel is usually the result of either grinding dust trapped between the two sliding surfaces or an incorrectly adjusted or loose bushing on the pinion shaft.

The grinder must be periodically cleaned and adjusted. The frequency of the cleaning is determined

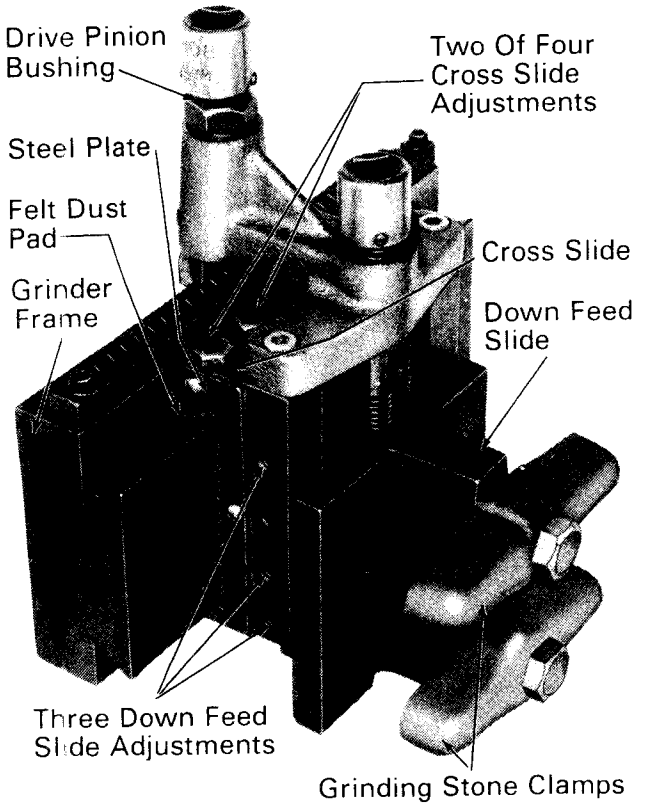



Fig.17 - Commutator Grinder Adjustments

by the use of the grinder and should be performed before there is any binding or jerky movement of the cross-slide.

Do not attempt to clean an assembled grinder by dipping in a solvent or by using air pressure to blow out dust. The grinder must be completely disassembled to clean.

## COMMUTATOR GRINDING

Commutator surface irregularities such as etching, roughness, or slight burning can often be corrected by resurfacing, using a grinding fixture and an adapter.

**NOTE**

In order to produce an acceptable commutator surface finish, it is imperative that the jig stone fixture be maintained in good condition. The in-feed and cross-feed gib ways must be clean and free from burrs so the device feeds smoothly. The gib keys must be adjusted so that no free play exists in the sliding assemblies, but not so tight to cause binding. Refer to Commutator Grinder Maintenance Section prior to grinding the commutator.

## GRINDER ADAPTER INSTALLATION

1. Remove the bolt securing the brush holder cable to the top brush holder. Remove the bolt securing the top brush holder clamp block and remove brush holder.

2. Tape the copper lug of the lead which was disconnected from the brush holder so it will not short against motor frame.

3. Install the adapter in the top brush holder position and secure it with the brush holder clamp block and bolt as shown in Fig. 18. Refer to Service Data for grinder adapter part number.

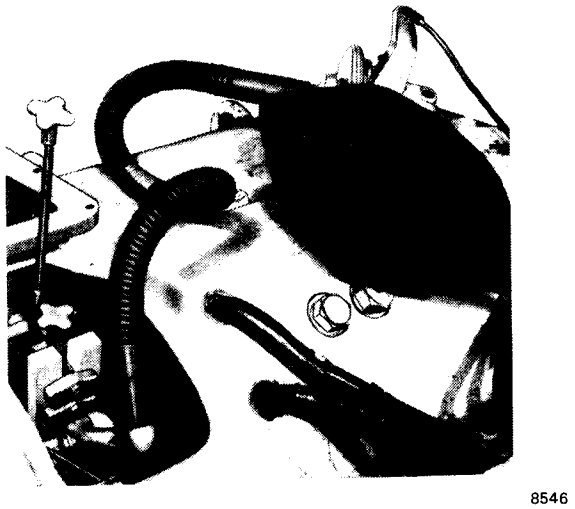



Fig.18 - Grinder Installation

## GRINDER INSTALLATION

1. Install alignment bar on the grinder down-feed slide. Check the alignment bar contact to the feed slide for zero clearance with a thickness gauge. Refer to Fig. 19. Any clearance at either side of the alignment bar contact surface indicates the bar is not parallel to the grinder. Refer to Service Data for alignment bar and grinder part numbers.

2. Install the grinder with the alignment bar on the adapter as shown in Fig. 18.

3. Position the armature so that the alignment bar will contact approximate center of the commutator bar. Parallel the alignment bar to the commutator surface using the small areas outside of the brush track at both ends of the commutator bar. The alignment bar should be within 0.08 mm (.003") of paralleling the commutator bar.

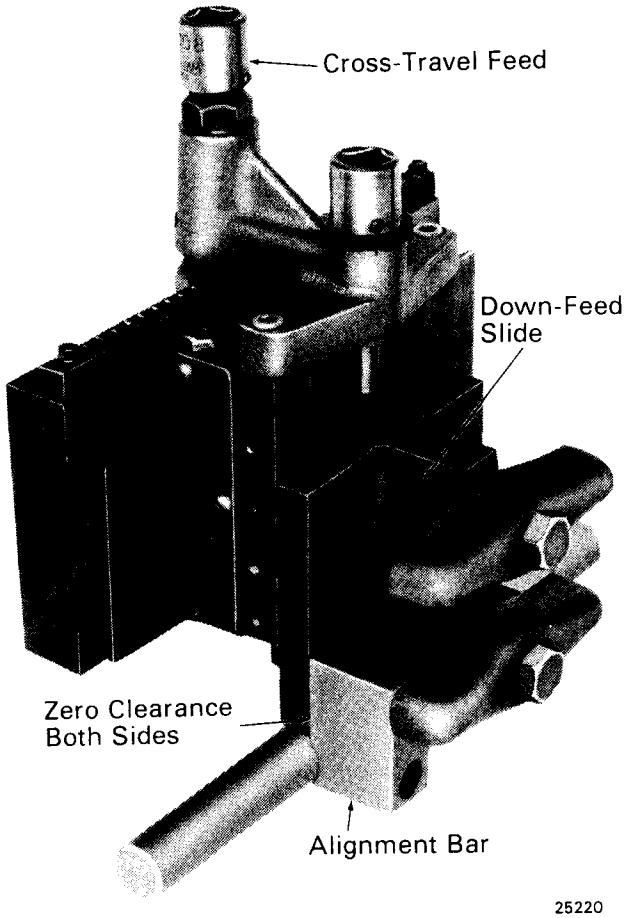



Fig.19 - Commutator Grinder Alignment Bar Installation

4. Remove the alignment bar from the grinder and install two grinding stones. Use finish grade stones. Mount the stones so that they are seated squarely on the commutator. Pull stones away from the commutator using the grinder cross-travel feed.

## GRINDING

The supply voltage to the traction motor can be a DC welding machine (or other source of DC electrical energy). The desired motor RPM for the grinding operation is approximately 1500 RPM. A satisfactory surface finish can be obtained at a reduced RPM, but the grinding time will be lengthened. Do not use a speed below 1000 RPM.

**NOTE**

Commutator can be ground by utilizing the unit's power. Contact EMD Service Department for details.

1. Disconnect all four leads of the motor or generator to be worked on, and tag the leads so they can be reconnected in their original position. Connect the leads to rotate the armature in a clockwise direction as viewed from the commutator end. Incorrect rotation (counterclockwise) could cause the grinding stones to chatter on the commutator. Connect the motor or generator leads as follows:

   Connect the positive supply lead to the "AA" lead of the motor or generator.

   Connect the "A" and the "F" leads of the motor or generator together.

   Connect the negative supply lead to the "FF" lead of the motor or generator.

**NOTE**

Brushes that are used in the grinding operation will have particles of grinding stone, dust, and copper imbedded in the surface that rides on the commutator. These particles can cause rapid deterioration of the commutator surface if the contaminated brushes are not removed from the motor. It is recommended that if the brushes are of sufficient length to continue service after the commutator is ground, they should be removed from the motor or generator before grinding is begun and then reinstalled after completion of the operation. Ensure brushes are marked so that they can be reinstalled in their original position. Brushes that are near the condemning limit for length should be used for the grinding operation.

2. Start the motor or generator and feed the grinding stones into the commutator slowly, using the down-feed handle until light contact is made. Proceed to grind the commutator by feeding the stones not more than 1/8 turn of the down-feed handle (45°) and move the stones across the commutator at a moderate speed for three complete passes. One pass being the movement across the commutator in either direction. Upon completion of the third pass, the stones can be fed down another 1/8 turn of the down-feed handle. Alternating the end of the commutator from which the stones are fed down will minimize the possibility of the development of a taper across the commutator. Continue this procedure until all low areas have been completely eliminated.

   If the commutator has been damaged to such an extent that the grinding process proves ineffective, the motor or generator will have to be removed and the commutator turned in a lathe.

**NOTE**

Feeding the grinding stones down more than 1/8 turn of the down-feed handle will result in very rapid wear of the grinding stones and also cause copper rollover on the trailing edge of the commutator bar. The copper rollover will have to be removed with the use of a de-burring tool. The recommended light feed will result in very small copper slivers on the trailing edge of the commutator bar which can easily be removed with a wire brush.

3. Remove the stones from the grinder and place them in their original box so that they will not become contaminated with oil or dirt. Remove the grinder and adapter.

4. With the armature rotating, clean the outer end of the commutator bars with a small piece of grinding stone.

5. Remove and discard the brushes used in grinding operation.

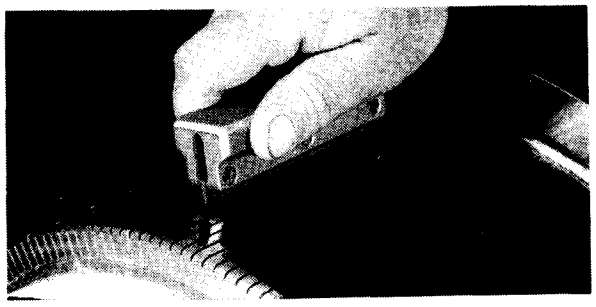
6. Thoroughly clean the motor or generator to remove all copper and grinding dust by directing clean, dry compressed air at moderate pressure on the face of the commutator. Blow out brush holders, stator windings, and end housing. Rotate the armature by hand when blowing out commutator slots.

7. Remove the slivers of copper on the trailing edge of the commutator bar with a clean wire brush. Position the brush close to the commutator riser with the wire bristles toward the riser face and roll the wire bristles down toward the commutator slot until they enter the slot. Move the brush across the commutator until the wire bristles have cleared the end of the commutator slot. While moving the brush across the commutator, apply moderate pressure in towards the commutator as well as pressure towards the trailing edge of the commutator bar. This procedure will remove all copper slivers on the bar and in the sots without damaging the commutator surface.

**NOTE**

The scratch marks will disappear when the soft grade of chalk stone is used to finish the seating of the brushes.

8. When the depth of the mica undercut between copper bars is less than 1.2 mm (3/64″), use commutator slot file, Fig. 20, to undercut the mica to proper depth. Do not exceed the undercut maximum depth of 2 mm (5/64″).



8536

Fig.20 - Cleaning Commutator Slots

9. Use chalk stone for final clean up of commutator. Do not use emery cloth or sandpaper for this purpose. Lubricant should never be used on commutators, as brushes have enough graphite to supply their own lubrication.

10. Rotate armature by hand and blow clean dry air into the commutator slots to remove any loose pieces of copper. Wipe dirt and copper dust away with clean cloths. Carefully inspect cleaning job and particularly the slots between commutator bars to see that all traces of undesired copper have been removed.

11. Replace brush holder assemblies and brushes. Install either new or the used brushes, but do not use any brush that had been left in the brush holder during the grinding operation. Reconnect cables.

12. Reconnect cables and install inspection cover. Check motor or generator for proper rotation before returning unit to service.

# ARMATURE BEARINGS

## SEALED GREASE LUBRICATED BEARINGS

Other than vertical mounted types, motors and generators are manufactured with sealed grease lubricated bearings. A specific type of grease is used. The amount and method by which the grease is applied is carefully controlled. Other than the vertical mounted type, effective with Model D69 motor or generator, and available for older models, is a sectionalized nylon insert installed in the commutator end bearing cover. The insert prevents an excessive amount of grease from being moved into rollers by "slumping" action caused by vibration. This reduces churning of the grease which in time causes the grease fibers to become soft and susceptible to purging. For information on repacking these bearings, refer to Grease Application To Bearing Caps And Covers procedure of this

Maintenance Instruction. Refer to Service Data for grease part number and quantity.

## ADDITIVE GREASE LUBRICATED BEARINGS (VERTICAL MOUNTED CONFIGURATION)

On vertical mounted type motors or generators, the coupling end is equipped with a roller bearing and the commutator end is equipped with a spherical roller thrust bearing. Both of these bearings are grease lubricated through fittings at either end. Add one ounce of grease to both ends every 60 days. For information on repacking these bearings, refer to Grease ApplicationTo Bearing Caps And Covers procedure of this Maintenance Instruction. Refer to Service Data for grease part number and quantity.

## NOISE TEST

Each time a motor or generator is removed, it should be operated so that a noise check can be made for faulty armature bearings. Performing this test will serve as a means of detecting faulty bearings thus preventing such a motor or generator from operating in service where it would likely result in a failure.

The power source and cable connections for this test are the same as described previously for rotating the armature during commutator grinding. The armature speed should be brought up to about 1500 RPM and then the power shut off to allow the armature to coast to a standstill. Carefully listen and try to determine the source of any noise that might be considered unusual. Experience and comparison with other motors or generators will help distinguish a faulty bearing from a normal one.

## BEARING CHANGEOUT

There are four basic armature shaft and bearing arrangements; the standard type which has the armature shaft extend through the coupling end of the motor or generator only, Fig. 21; a through armature shaft which protrudes from both ends of the motor or generator, Fig. 22; a commutator end stubshaft provision with either a standard shaft or through shaft, Fig. 23; and a spherical roller thrust bearing with either a standard shaft or through shaft, intended for vertical mounting, Fig. 24.

**NOTE**

On all types of motors and generators built prior to late 1975, the commutator end and coupling end bearing arrangement included an oil thrower between the inner spacer and the bearing inner race (as shown in commutator end of vertical arrangement, Fig. 24). All bearing caps also contained labyrinth grooves.

Anti-churn insert not included on all types.

Bearing changeout procedures will apply to all type motors or generators unless specifically identified.

## ARMATURE REMOVAL TO REPAIR OR REPLACE BEARING ASSEMBLY

This procedure is to remove the armature from the stator, leaving the bearing housing and bearing outer race in the stator and the bearing inner race on the armature shaft. If bearing is not to be disassembled or replaced, perform Armature Removal With Complete Bearing Assembly Intact procedure.

Refer to Figs. 21, 22, 23, or 24 as applicable during this procedure.

**NOTE**

Refer to Service Data for tools or fixtures required to remove armature.

1. Remove bolts holding commutator end bearing housing to the stator frame.

2. Clean out 7/8"-9 NC jack bolt holes in the coupling end bearing housing with a tap. Insert three 7/8"-9 jack bolts.

3. On standard type bearing arrangement, Fig. 21, remove commutator end bearing cover (9), bearing retainer plate (8), and thrust collar (10).

4. On through shaft type bearing arrangement, Fig. 22, perform the following:

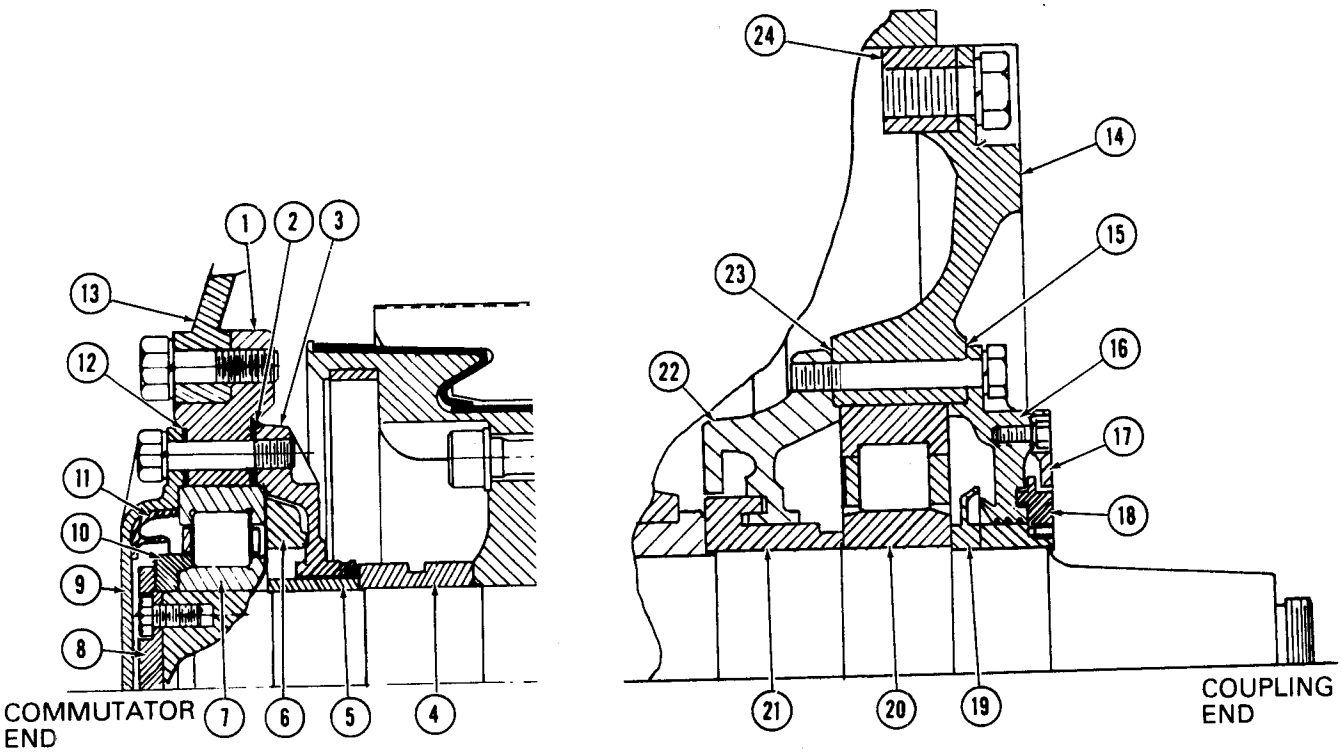
   a. Remove guard (9) and remove retainer plate (10).

   b. Apply puller plate and studs through drive hub (11). Line up puller plate and ensure puller plate is pulling equally on all studs. Apply sufficient heat to remove drive hub.

   c. Pry up ears of lockwasher (8) with a screw driver to expose locknut (7) flats. Remove locknut using a 5" spanner wrench and sledge hammer.

   d. Apply sufficient heat to remove bearing outer seal (12).

   e. Remove commutator end bearing cover (14).



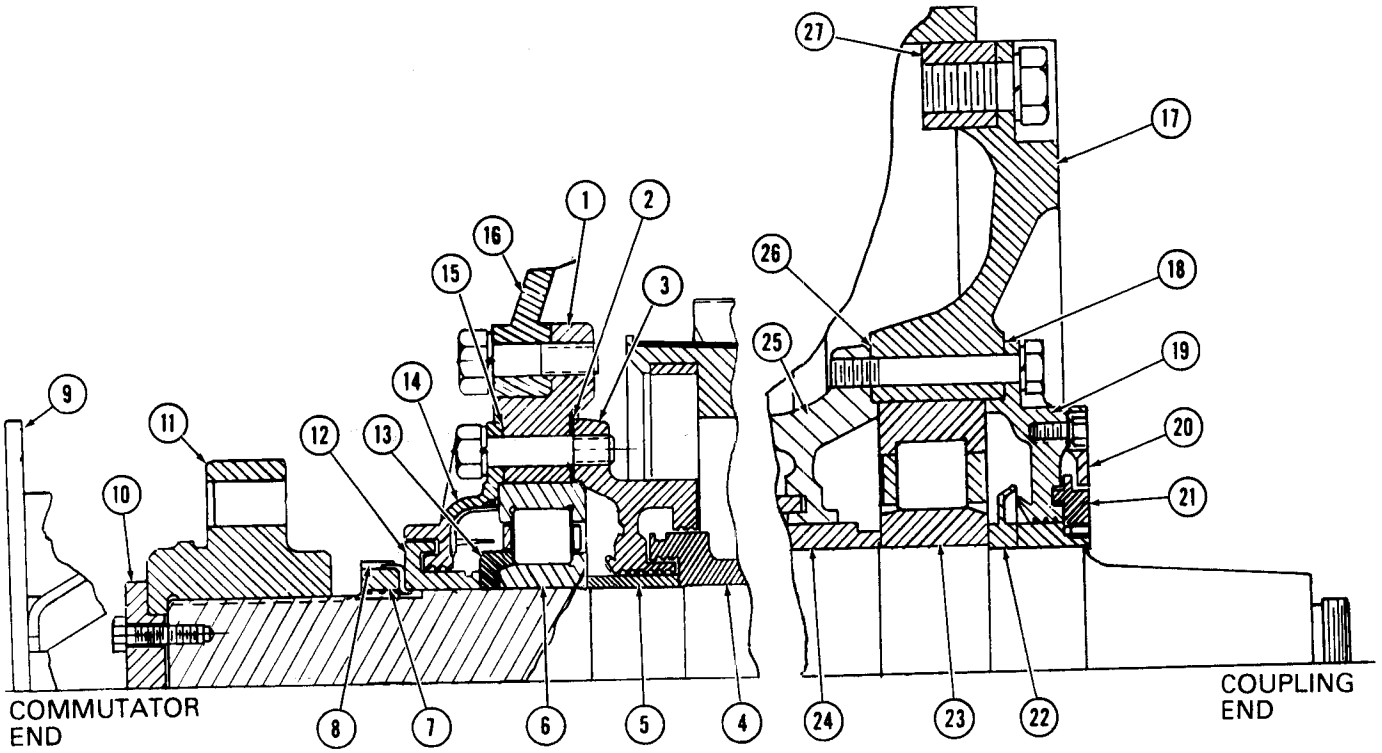

1. Bearing Housing
2. Cap Gasket
3. Bearing Cap
4. Collar
5. Inner Spacer
6. Anti-Churn Insert
7. Bearing
8. Retainer Plate
9. Bearing Cover
10. Thrust Collar
11. Anti-Churn Insert
12. Cover Gasket
13. Stator Frame
14. Bearing Housing
15. Cover Gasket
16. Bearing Cover
17. Outer Seal
18. Oil Ring
19. Oil Thrower
20. Bearing
21. Inner Seal
22. Bearing Cap
23. Cap Gasket
24. Stator Frame

**NOTE**

Bearing components may vary between model types. Illustrations presented to show disassembly and assembly sequence.

23873

Fig.21 - Standard Type Bearing Arrangement



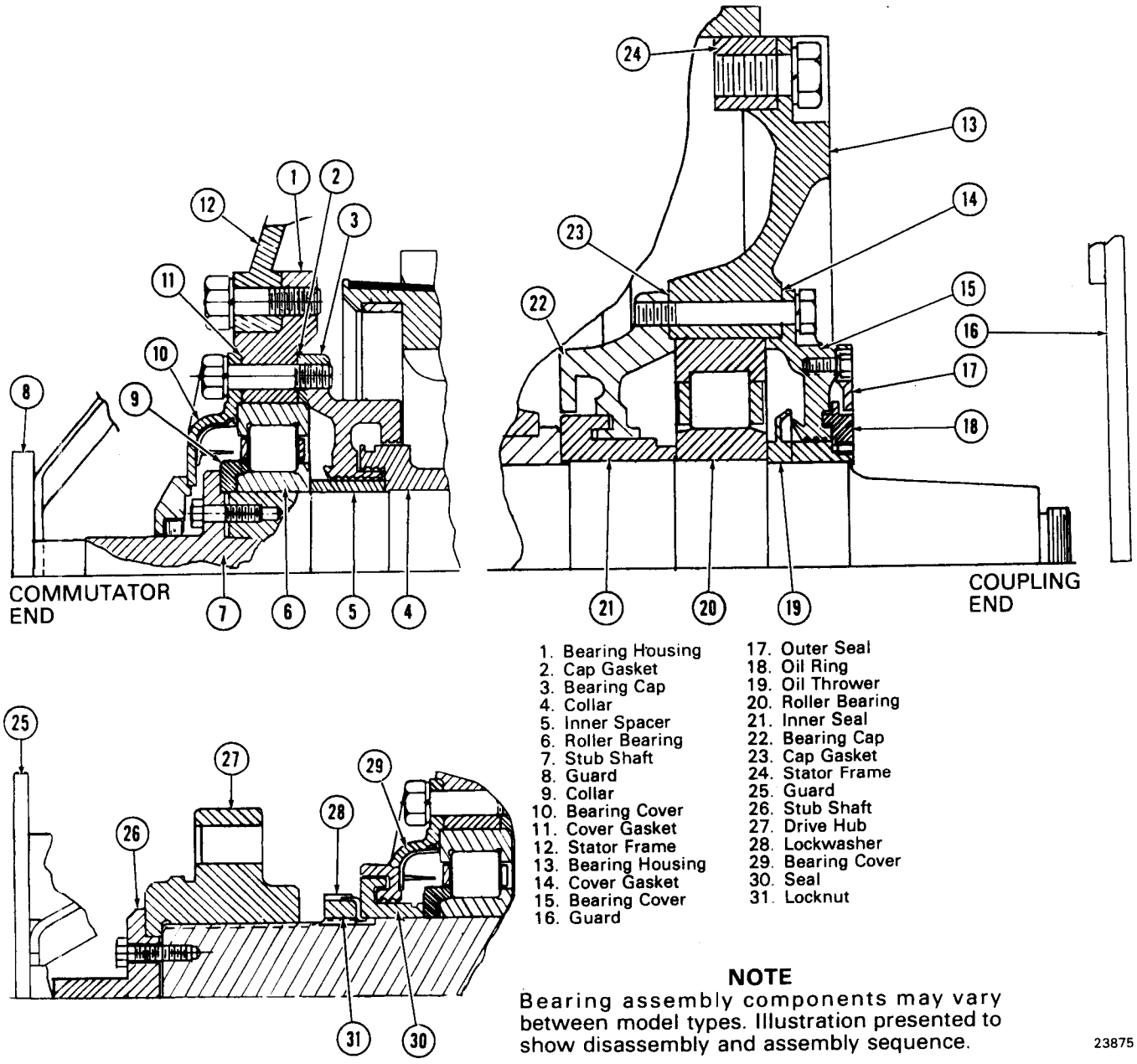

**NOTE**

Bearing assembly components may vary between model types. Illustration presented to show disassembly and assembly sequence.

1. Bearing Housing
2. Cap Gasket
3. Bearing Cap
4. Collar
5. Inner Spacer
6. Roller Bearing
7. Locknut
8. Lockwasher
9. Guard
10. Retainer Plate
11. Drive Hub
12. Outer Seal
13. Collar
14. Bearing Cover
15. Cover Gasket
16. Stator Frame
17. Bearing Housing
18. Cover Gasket
19. Bearing Cover
20. Outer Seal
21. Oil Ring
22. Oil Thrower
23. Roller Bearing
24. Inner Seal
25. Bearing Cap
26. Cap Gasket
27. Stator Frame

23874

Fig.22 – Through Shaft Type Bearing Arrangement



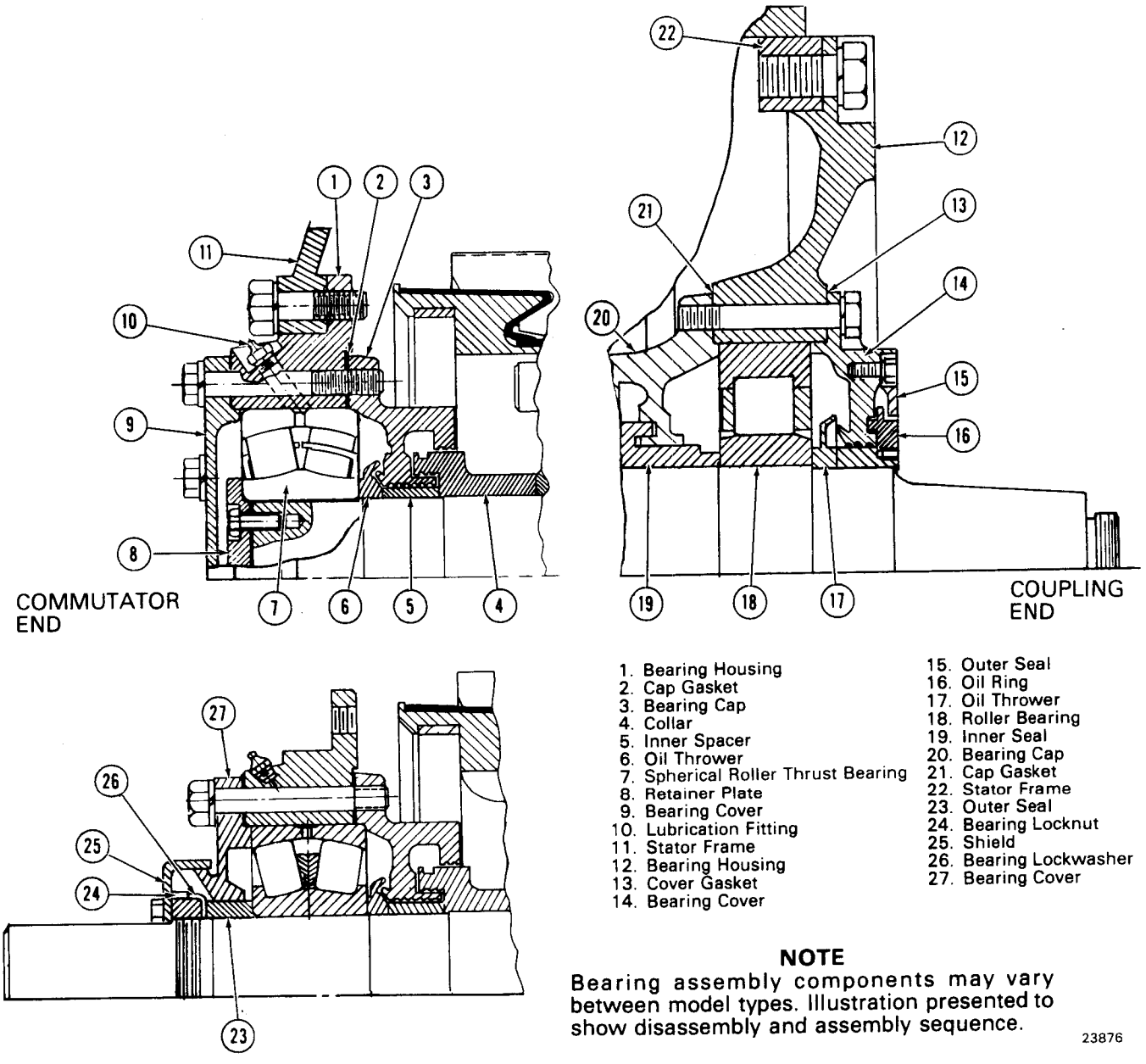

1. Bearing Housing
2. Cap Gasket
3. Bearing Cap
4. Collar
5. Inner Spacer
6. Roller Bearing
7. Stub Shaft
8. Guard
9. Collar
10. Bearing Cover
11. Cover Gasket
12. Stator Frame
13. Bearing Housing
14. Cover Gasket
15. Bearing Cover
16. Guard
17. Outer Seal
18. Oil Ring
19. Oil Thrower
20. Roller Bearing
21. Inner Seal
22. Bearing Cap
23. Cap Gasket
24. Stator Frame
25. Guard
26. Stub Shaft
27. Drive Hub
28. Lockwasher
29. Bearing Cover
30. Seal
31. Locknut

**NOTE**

Bearing assembly components may vary between model types. Illustration presented to show disassembly and assembly sequence.

23875

Fig.23 – Stub Shaft Type Bearing Arrangement




1. Bearing Housing
2. Cap Gasket
3. Bearing Cap
4. Collar
5. Inner Spacer
6. Oil Thrower
7. Spherical Roller Thrust Bearing
8. Retainer Plate
9. Bearing Cover
10. Lubrication Fitting
11. Stator Frame
12. Bearing Housing
13. Cover Gasket
14. Bearing Cover
15. Outer Seal
16. Oil Ring
17. Oil Thrower
18. Roller Bearing
19. Inner Seal
20. Bearing Cap
21. Cap Gasket
22. Stator Frame
23. Outer Seal
24. Bearing Locknut
25. Shield
26. Bearing Lockwasher
27. Bearing Cover

**NOTE**

Bearing assembly components may vary between model types. Illustration presented to show disassembly and assembly sequence.

23876

Fig.24 – Vertical Mounted Type Bearing Arrangement

5. On stub shaft type bearing arrangement, Fig. 23, perform the following:

   Regular Shaft

   a. Remove guard (8) from stator frame.

   b. Remove commutator end bearing cover (10).

   c. Remove bolts holding stub shaft (7) to armature shaft and remove stub shaft.

   Through Shaft

   a. Remove guard (25) from stator frame.

   b. Remove bolts holding stub shaft (26) to armature shaft and remove stub shaft.

   c. Apply puller plate and studs through drive hub (27). Line up puller plate and ensure plate is pulling equally on all studs. Apply sufficient heat to remove drive hub.

   d. Pry up lockwasher (28) ears with a screw driver to expose locknut (31) flats. Remove locknut using a 5" spanner wrench and sledge hammer.

   e. Apply sufficient heat to remove outer seal (30).

   f. Remove commutator end bearing cover (29).

6. On vertical mounted type bearing arrangement, Fig. 24, perform the following:

   Regular shaft

   a. Remove bearing cover (9).

   b. Remove bearing retainer plate (8).

   Through shaft

   a. Remove shield (25).

   b. Pry up lockwasher (26) ears with a screw driver to expose locknut (24) flats. Remove locknut using a 5" spanner wrench and sledge hammer.

   c. Apply sufficient heat to remove outer seal (23).

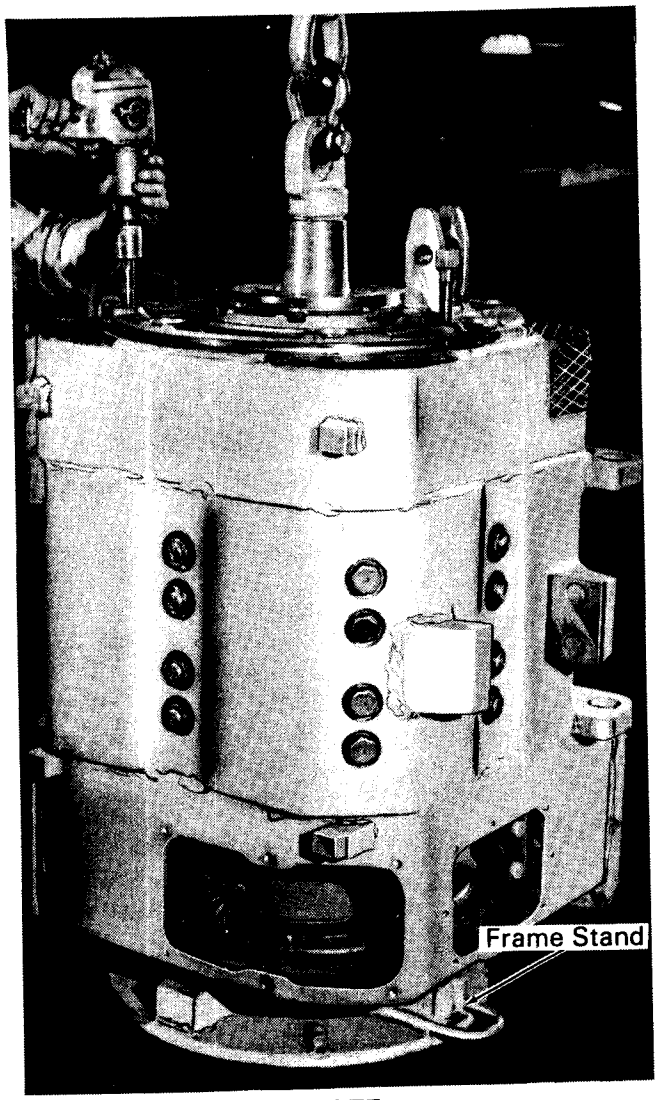
   d. Remove commutator end bearing cover (27).

**NOTE**

In Step 7, frame mounting stand 8064917 not applicable for through shaft armature. A stand should be constructed to allow the shaft to clear the floor while supporting the stator frame.

7. Apply lifting eye bolt to coupling end of the shaft. Lift traction motor with a crane from stand and place in a vertical position, commutator end down, on frame stand, Fig. 25. Frame stand will support the stator frame in the proper position for removing armature.

8. Remove the coupling end housing bolts. Raise armature slightly with the aid of a hoist. Keep hoist hook centered over the armature shaft to prevent armature damage.




**NOTE**
Motor pictured is not the correct model, but is used to show proper disassembly position.

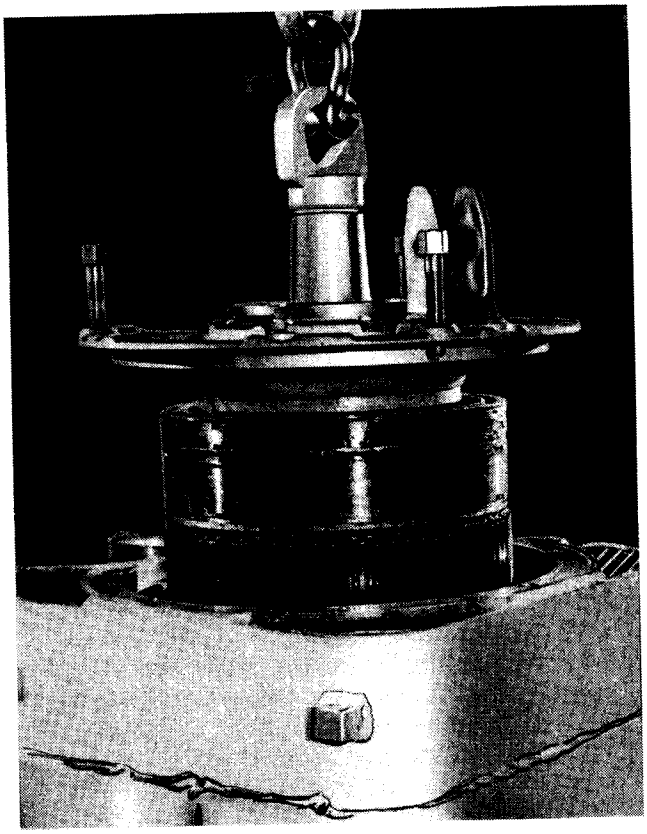
24111

Fig.25 - Preparing For Armature Removal

**CAUTION**

In Step 9, do not tighten jacking bolts more than one half turn at a time. Tightening the bolts more can cock the bearing housing and damage the bearing.

9. If housing is still held by frame, tighten coupling end jacking bolts only one half turn alternately until housing is free. After housing is released from the frame, remove coupling end jacking bolts. Lift the armature out of the frame, Fig. 26. Use care to prevent contact between the armature and the frame.



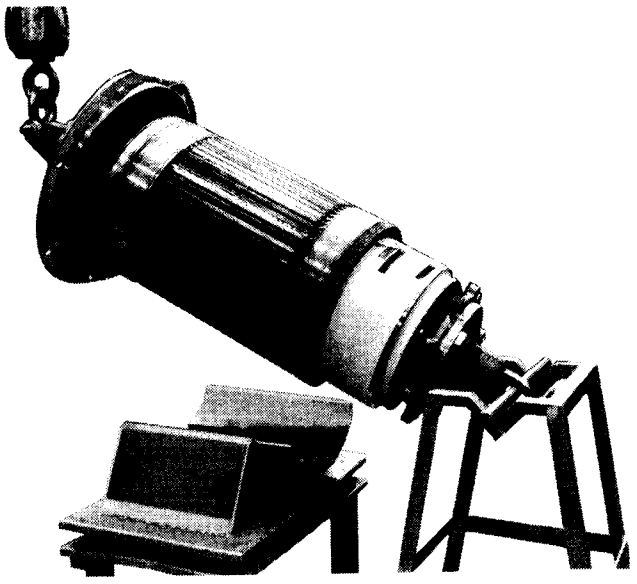
9931

Fig.26 - Removing Armature Assembly

10. Apply commutator end lifting eye to the commutator end of armature shaft and insert bar through eye. Refer to Service Data for applicable commutator end lifting eye. Use steel stand to pivot the armature while setting the armature into a saddle or rack, Fig. 27. Do not set the armature on the commutator or bands. Support the armature on the core sections only. Remove the coupling end lifting eye bolt and the commutator end lifting eye.

**NOTE**

Any time the armature is removed from stator, the stator windings should be thoroughly cleaned. Ensure cables are properly tied to the supporting rings and that the insulation is not damaged. A high pot test should also be performed, following a megohmmeter reading of not less than 2 megohms. Refer to Service Data for high pot test values.



23877

Fig.27 - Lowering Armature (With Bearing Disassembled) Into Saddle

## ARMATURE REMOVAL WITH COMPLETE BEARING ASSEMBLY INTACT

This procedure is to remove the armature from the stator with the complete bearing assembly remaining on the armature shaft. Refer to Armature Removal To Repair Or Replace Bearing Assembly procedure if bearing is to be removed.

Refer to Figs. 21, 22, 23, or 24 as applicable during this procedure.

**NOTE**

Refer to Service Data for tools or fixtures required to remove armature and bearing assemblies.

1. Remove 1″-8 bolts holding the commutator end bearing housing to the stator frame. Clean out 5/8″-11 NC jack bolt holes in the stator frame with a tap. Insert three 5/8″-11 NC jack bolts in jack bolt holes.

2. Loosen coupling end housing bolts so that they protrude from stator housing 19 mm (3/4″). Do not remove these bolts at this time. Clean out 7/8″-9 NC jack bolt holes with a tap. Insert three 7/8″-9 jack bolts in jack bolt holes.

3. On through shaft type bearing arrangement, Fig. 22, perform the following:

   a. Remove guard (9) and remove retainer plate (10).

   b. Apply puller plate and studs through drive hub (11). Line up puller plate and ensure puller plate is pulling equally on all studs. Apply sufficient heat to remove drive hub.

4. On stub shaft type bearing arrangement, Fig. 23, perform the following:

   Regular Shaft

   a. Remove guard (8) from stator frame.

   b. Remove commutator end bearing cover (10).

   c. Remove bolts holding stub shaft (7) to armature shaft and remove stub shaft.

   Through Shaft

   a. Remove guard (25) from stator frame.

   b. Remove bolts holding stub shaft (26) to armature shaft and remove stub shaft.

   c. Apply puller plate and studs through drive hub (27). Line up puller plate and ensure plate is pulling equally on all studs. Apply sufficient heat to remove drive hub.

5. Using jack bolts, simultaneously jack out both coupling end and commutator end bearing housings. Use care to drive housings evenly. If difficulty is experienced in starting the commutator end bearing housing to move out of frame, insert three of the housing to frame bolts. Screw housing to frame bolts sufficiently into the housing so that they may be tapped with a copper bar or copper hammer to loosen the housing. When housing is loosened, remove the housing to frame bolts and continue using jack bolts. Continue to drive out both housing until the coupling end housing is against the bolts.

**CAUTION**

Do not force either housing ahead of the other. There is 3 mm to 5 mm (1/8" to 3/16") between the two bearing assemblies when assembled on the armature shaft. When this play is taken up, the commutator end bearing thrust collar is taking the load. Also, caution must be used when driving the jack bolts to prevent damage to the bearings and bearing housings. A few turns on each jack bolt will keep the bearing housings moving straight.

6. Remove commutator end jack bolts.

**NOTE**

In Step 7, frame mounting stand 8064917 not applicable for through shaft armature. A stand should be constructed to allow the shaft to clear the floor while supporting the stator frame.

7. Apply lifting eye bolt to the coupling end of the shaft. Lift traction motor with a crane from the stand and place in a vertical position, commutator end down, on frame stand, Fig. 25. Frame stand will support the stator frame in the proper position for removing the armature.

8. Remove coupling end housing bolts. Raise armature slightly with the aid of a crane, Fig. 25. Keep hook centered over the armature shaft to prevent armature damage.

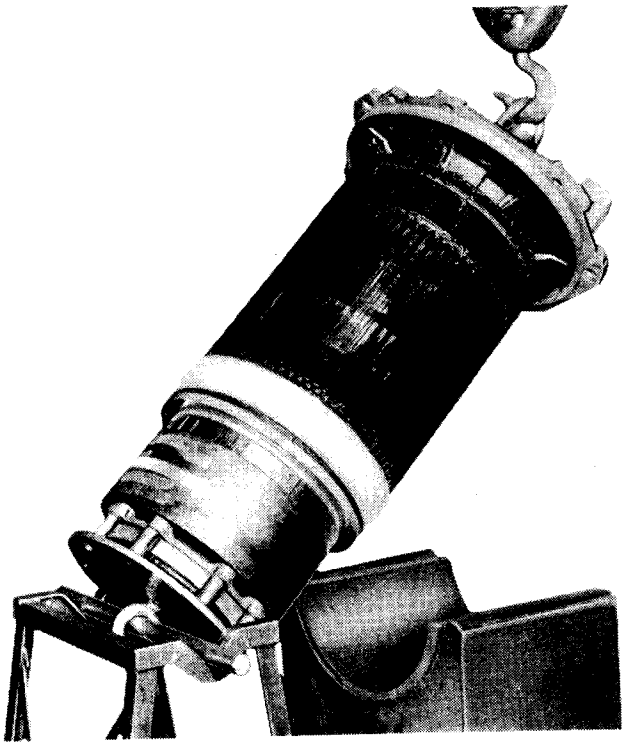
**CAUTION**

In Step 9, do not tighten jacking bolts more than one half turn at a time. Tightening bolts more can cock the bearing housing and damage the bearing.

9. If coupling end housing is still held by the frame, tighten coupling end jack bolts only one half turn alternately until housing is free. After housing is released from the frame, remove coupling end jack bolts. Lift armature out of the frame, Fig. 26. Use care to prevent contact between the armature and the frame.

10. On standard shaft armature, apply armature turning plate to the commutator end bearing housing and insert bar through eye in plate, Fig. 28. Use steel stand to pivot the armature while setting the armature into a saddle or rack. Do not set the armature on the commutator or the bands. Support the armature on the core sections only. Remove the coupling end lifting eye bolt and remove the turning plate from the commutator end.

11. On through shaft armature, apply commutator end lifting eye to the commutator end of armature shaft and insert bar through eye, Fig. 27. Pivot armature as described in Step 10.



16867

Fig.28 – Lowering Armature (With Complete Bearing Assembly) Into Saddle

## COMMUTATOR END BEARING ASSEMBLY REMOVAL FROM STATOR AND ARMATURE

If the commutator end bearing assembly was disassembled when armature was removed from the stator, follow this procedure to remove the commutator end bearing housing and bearing outer race from the stator and the bearing inner race from the armature shaft.

**NOTE**

Refer to Service Data for tools or fixtures required to remove commutator end bearing.

Refer to Figs. 21, 22, 23, or 24 as applicable during this procedure.

1. Insert three 5/8"-11 NC jack bolts in commutator end of stator frame and jack out bearing housing along with bearing outer race and rollers. Use caution to prevent damage to housing. Do not cock or force the housing.

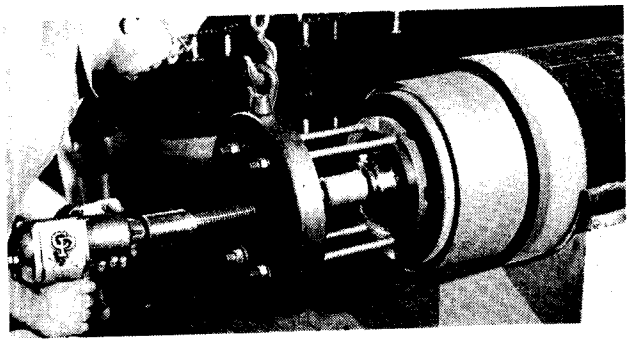
**CAUTION**

In Step 2, ensure pulling plate is pulling equally on all studs to prevent damage to the bearing cap.

2. Apply puller plate and studs to bearing cap, Fig. 29, and remove the bearing cap, oil thrower, if applicable, and inner race. Do not drop the inner race as it is pulled from the shaft.

3. If bearing collar and inner spacer remaining on shaft are in good condition, do not remove.

4. Remove bearing outer race from bearing housing by completely supporting the face of the bearing race, and pressing the bearing housing off the bearing race with a bearing press.



9929

Fig.29 - Removing Commutator End Bearing Cap, Oil Thrower, And Inner Race

**NOTE**

If bearing parts are not to be used immediately, they should be coated with Shell Cyprina RA Grade 3 to prevent corrosion.

## COUPLING END BEARING ASSEMBLY REMOVAL

**NOTE**

Refer to Service Data for tools or fixtures required to remove coupling end bearing assembly.

Refer to Figs. 21, 22, 23, or 24 as applicable during this procedure.

1. Clean bearing housing, bearing cover, outer seal, and oil ring so that no dirt will enter bearing.

2. Remove six 3/8"-11 bolts from outer seal and remove seal.

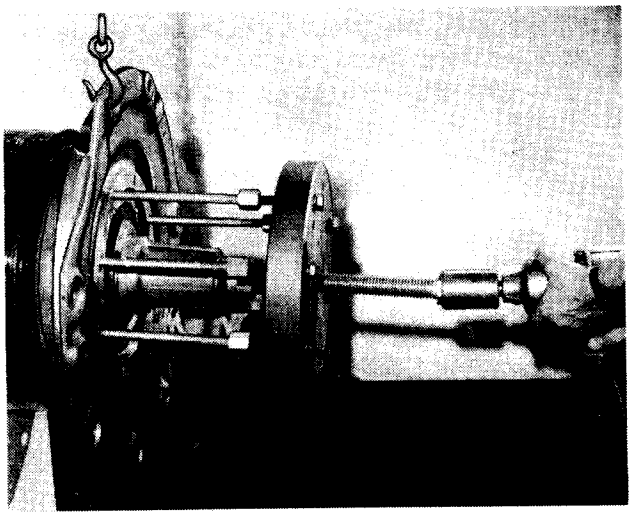
**CAUTION**

Remove outer seal and oil ring before attempting to remove bearing assembly. Failure to remove seal and ring could result in damage to bearing cap when pulling assembly.

3. Apply heat quickly and sparingly to oil ring slinger and remove oil ring.

4. Remove the eight 5/8"-11 bolts from bearing cover.

5. Apply puller plate and studs through bearing cover into the bearing cap, Fig. 30.



9928

Fig.30 - Removing Coupling End Bearing Assembly

6. Line up puller plate and remove complete coupling end bearing assembly. Ensure pulling plate is pulling equally on all studs to prevent damage to bearing cap.

7. When bearing assembly is free of shaft, remove puller plate and all but one stud. One stud should be left in assembly to prevent parts from falling.

8. Support bearing assembly with a crane and slide bearing assembly and housing off the bearing inner race.

9. Remove bearing outer race from bearing housing by completely supporting the face of the bearing race, and pressing the bearing housing off the bearing race with a bearing press.

10. Apply sufficient heat to bearing inner seal to remove inner seal by hand.

**NOTE**

If bearing parts are not to be used immediately, they should be coated with Shell Cyprina RA Grade 3 to prevent corrosion.

## BEARING ASSEMBLY TO ARMATURE

1. Place the armature in a horizontal position on a cradle, supporting the armature on the core section only.

2. Clean shaft diameters and ensure pinion end threads are not damaged. Remove any grit or dust from retaining plate bolts holes on the commutator end of the shaft.

3. Ensure bearing parts are clean. Refer to Figs. 31 through 35, for proper location of bearing assembly.

**NOTE**

The bearing seal arrangement has been improved since late 1975. If replacing commutator end inner spacer, use the current 51.05 mm (2.010") wide spacer 8499802. The current spacer is wider than previous spacer and eliminates the oil slinger.

If replacing coupling end inner oil ring and outer grease seal, replace the inner ring with the current 68.85 mm (2.750") inner seal 8499803.

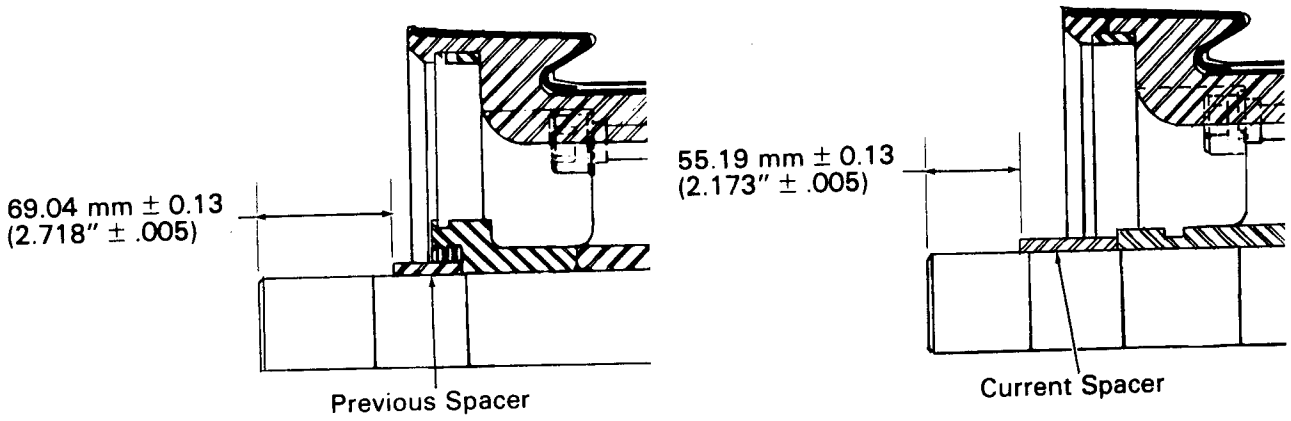
4. Heat the bearing parts to be shrunk on the shaft by suspending parts in SAE 50 oil (with a safe flash point) at a temperature of 115°-125° C (240°-260° F). The oil container should have a false perforated bottom which will prevent direct transmission of heat from the heating unit to the bearing parts. Wipe oil off all bearing parts with clean bound-edge cloths before applying to shaft.

**CAUTION**

Do not use a torch, induction heater, brazing tongs, or any uncontrolled heat. Direct heating of bearing parts will warp or metallurgically upset the parts.

5. If commutator end inner spacer or coupling end inner seal were removed, shrink inner spacer and/or inner seal onto the shaft. Ensure inner spacer is tight against the commutator end collar and the inner seal is tight against the armature core quill. Use a brass tube large enough to fit over the shaft to hold bearing parts in proper position.

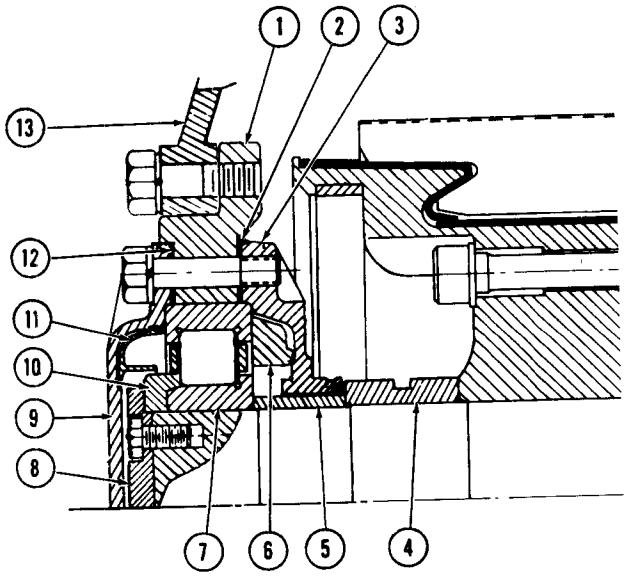
6. If commutator end inner spacer was removed and reassembled or if a new inner spacer is being used, check the distance between the end




NOTE
Runout of outer face of inner spacer shall not exceed 0.013 mm (.0005") total indicator runout when checked from bearing surface.

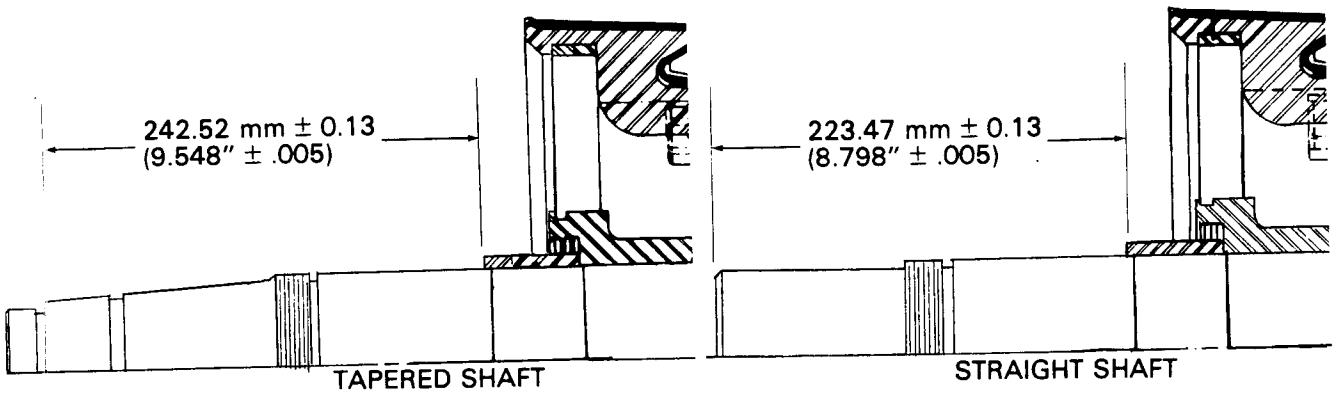
**INNER SPACER DIMENSION**

1. Bearing Housing
2. Cap Gasket
3. Bearing Cap
4. Collar
5. Inner Spacer
6. Anti-Churn Insert
7. Bearing
8. Retainer Plate
9. Bearing Cover
10. Thrust Collar
11. Anti-Churn Insert
12. Cover Gasket
13. Stator Frame




23878

Fig.31 – Commutator End Standard Type Bearing Assembly




NOTE
Runout of outer face of inner spacer shall not exceed 0.013 mm (.0005") total indicator runout when checked from bearing surface.

**INNER SPACER DIMENSION**

1. Bearing Housing
2. Cap Gasket
3. Bearing Cap
4. Collar
5. Inner Spacer
6. Roller Bearing
7. Locknut
8. Lockwasher
9. Guard
10. Retainer Plate
11. Drive Hub
12. Outer Seal
13. Thrust Collar
14. Bearing Cover
15. Cover Gasket
16. Stator Frame

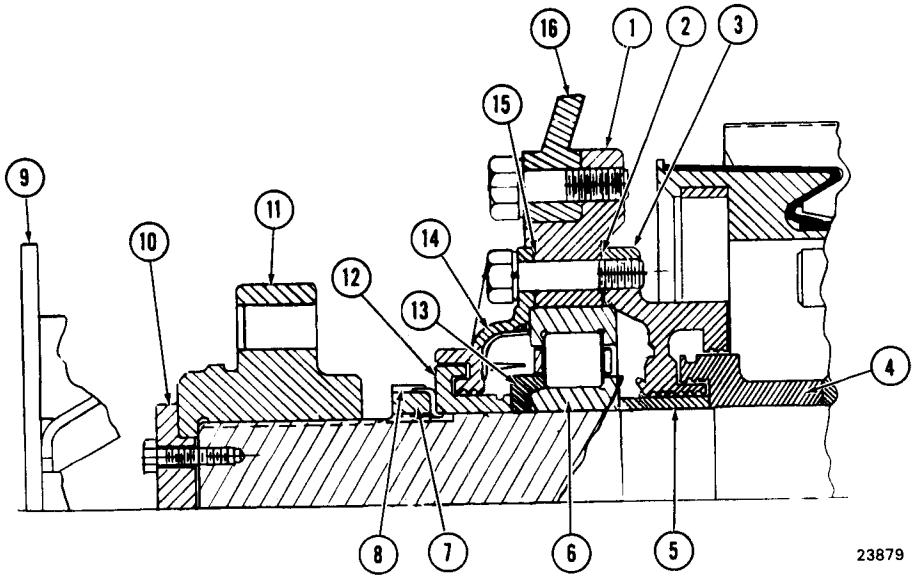
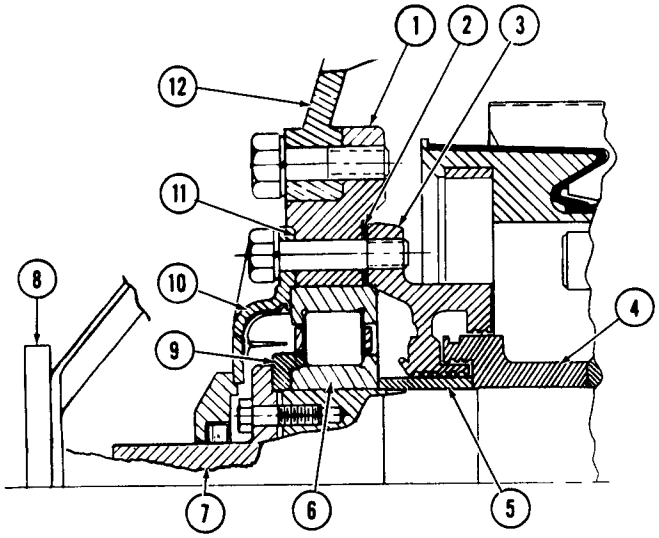
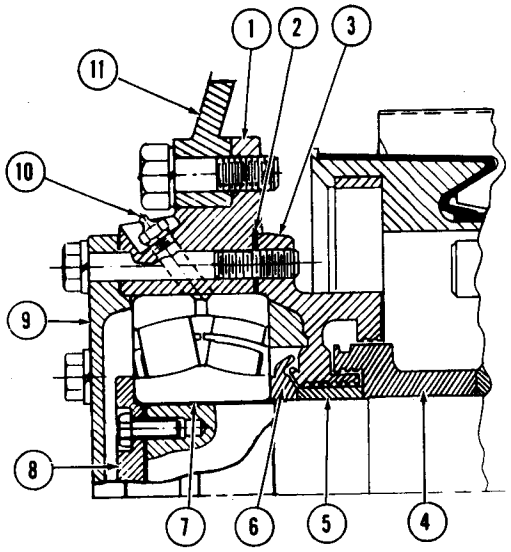
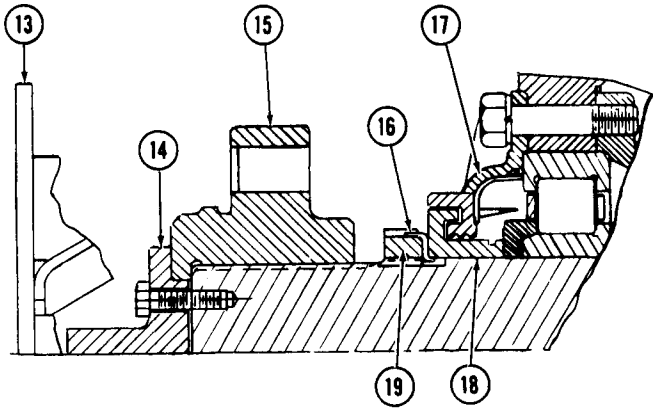



Fig.32 - Commutator End Through Shaft Type Bearing Assembly



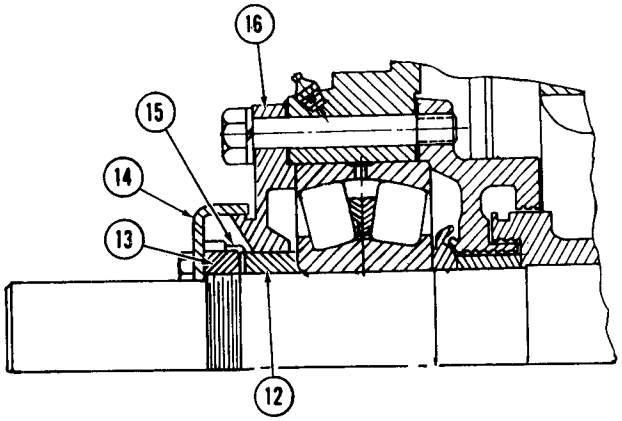

STANDARD




1. Bearing Housing
2. Cap Gasket
3. Bearing Cap
4. Collar
5. Inner Spacer
6. Roller Bearing
7. Stub Shaft
8. Guard
9. Thrust Collar
10. Bearing Cover
11. Cover Gasket
12. Stator Frame
13. Guard
14. Stub Shaft
15. Drive Hub
16. Lockwasher
17. Bearing Cover
18. Outer Seal
19. Locknut

23880

Fig.33 - Commutator End Stub Shaft Type Bearing Assembly

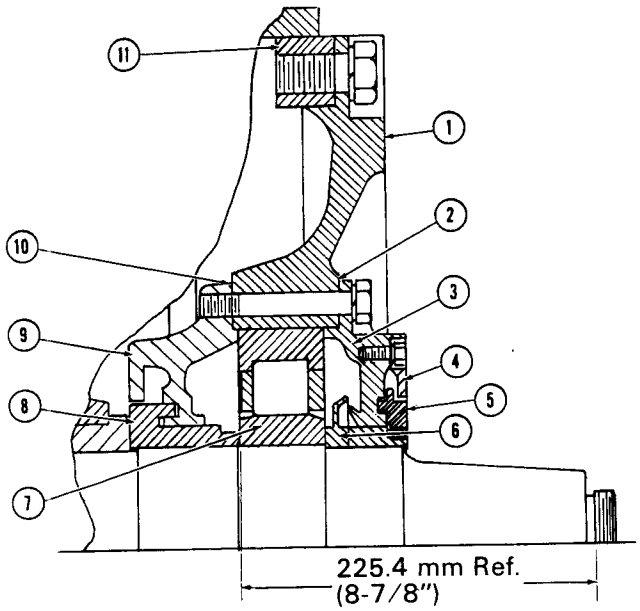



THROUGH-SHAFT

1. Bearing Housing
2. Cap Gasket
3. Bearing Cap
4. Collar
5. Inner Spacer
6. Oil Thrower
7. Spherical Roller Thrust Bearing
8. Retainer Plate
9. Bearing Cover
10. Lubrication Fitting
11. Stator Frame
12. Outer Seal
13. Bearing Locknut
14. Shield
15. Bearing Lockwasher
16. Bearing Cover

23881

Fig.34 - Commutator End Vertical Mounted Type Bearing Assembly




**NOTE**

Bearing housing may vary between motor or generator types. Illustration presented to show assembly sequence.

1. Bearing Housing
2. Cover Gasket
3. Bearing Cover
4. Outer Seal
5. Oil Ring
6. Oil Thrower
7. Bearing
8. Inner Seal
9. Bearing Cap
10. Cap Gasket
11. Stator Frame

23882

Fig.35 - Coupling End Bearing Arrangement

of the shaft and the inner spacer. Refer to Fig. 31 or 32 as applicable. Machine outer face of inner spacer if required to obtain proper dimension. Use care not to cut into shaft if spacer is machined.

7. Check inner spacer outer face runout from the bearing surface. Inner spacer outer face runout shall not exceed 0.013 mm (.0005") total indicator reading.

8. If coupling end inner seal was removed and reassembled or if a new inner seal is used, check the distance between the end of the shaft and the inner seal. Refer to Fig. 35.

9. Apply grease to commutator end and coupling end bearing caps. Refer to Grease Application To Bearing Caps And Covers procedure of this Maintenance Instruction.

10. Install gaskets to bearing caps.

**NOTE**

If motor is equipped with SKF through hardened commutator end bearing assembly 9428485 (inner race 457058, outer race 9428559), it is recommended that bearing assembly be replaced with SKF carburized commutator end bearing assembly 9437296 (inner race 9437315, outer race 9437297) at first motor overhaul.

The carburized races have greater impact strength than the through hardened races. The through hardened bearing assembly 9428485 is no longer available from Electro-Motive as a replacement part.

11. Shrink the commutator end and coupling end inner bearing races onto the shaft.

    Coupling end inner race is positioned on the shaft with the indentification numbers facing outboard.

    Commutator end inner race 9437315 is positioned on the shaft with the identification numbers facing inboard. Commutator end inner race 7451318 is positioned on the shaft with the identification numbers facing outboard.

    Push each race against the previously applied part. Rotate inner race while applying pressure until piece siezes the shaft. Ensure bearing inner races are not distorted, misaligned, or out of position. Remove all traces of oil from the races.

12. Using a suitable bearing press, completely support the face surface of the outer roller bearing race and press bearing into the bearing housing. Keep bearing level and not cocked in bore. If bearings have been in service previously, install bearings so that the former top of the outer race (before bearing was removed from the housing) is assembled in a position 90° to either side of the housing top.

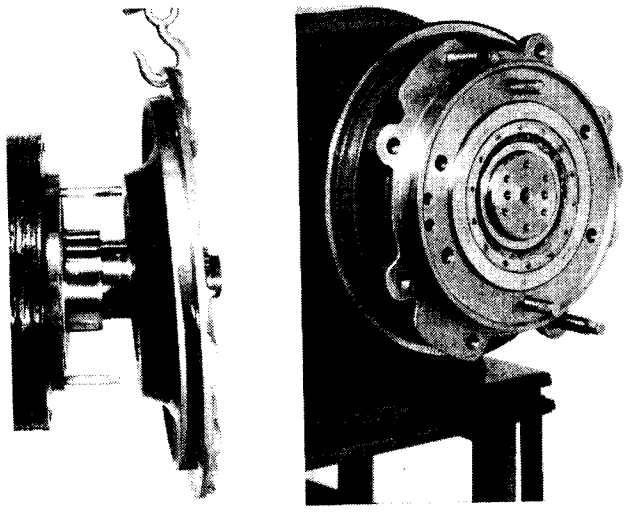
    The face of the commutator end outer race should project 5.08 mm (.200") from each side of the housing when properly seated. The face of the coupling end outer race should be 8.46 mm (.333") from the outer face of the housing.

    Coupling end outer race is positioned in the housing with the identification numbers facing outboard.

    Commutator end outer race 9437297 is positioned in the housing with the identification numbers facing inboard. Commutator end outer race 7451864 is positioned in the housing with the identification numbers facing outboard.

13. Ensure grease is applied to the bearings before assembling bearings and housings to the armature.

14. Apply a light coating of grease to the bearing inner races and install two locating studs to the coupling end and commutator end bearing caps, Fig. 36. These studs will keep the bearing cap in position when the housings are assembled to the armature. Refer to Service Data for locating stud part numbers.



23883 10037

Fig.36 - Commutator End And Coupling End Line Up Studs

15. Assemble the bearing housing assemblies to the armature, being careful not to cock or force rollers over inner face.

16. Assemble bearing covers to the bearing assemblies. Remove locating studs.

17. Use four bolts on the coupling end and three bolts on the commutator end to hold covers in position. The covers will have to be removed after armature assembly is placed in stator to inspect the bearings for alignment.

## ARMATURE INSTALLATION AND ALIGNMENT

Ensure stator has been cleaned, inspected, and repaired if required. Ensure brush holders are installed in stator prior to assembly of armature. Refer to Service Data for tools or fixtures required to install and align armature.

**NOTE**

Motors pictured are not necessarily the correct model, but are used to show proper assembly positions.

1. Place stator on a frame stand with commutator end down. Ensure bolt holes of stator clear the blocks on stand to allow for locating pins at commutator end of armature to clear as armature is lowered into stator. Ensure coupling end stator bore face is level in all directions.

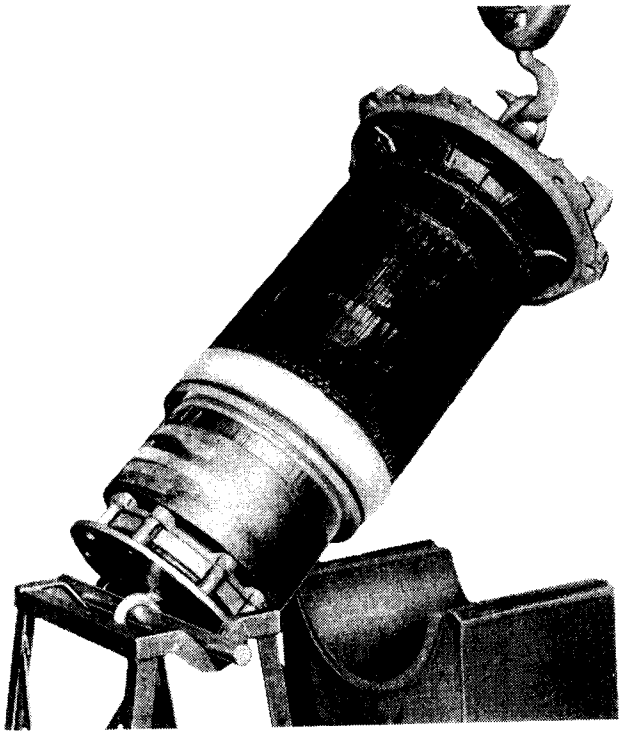
2. Position brush holders all the way back against brush holder blocks to allow clearance for the commutator.

3. Install four locating pins in bearing housing bolt holes of coupling end of stator. Install four line up studs to the commutator end bearing housing.

4. Apply lifting eye bolt to the coupling end of the shaft.

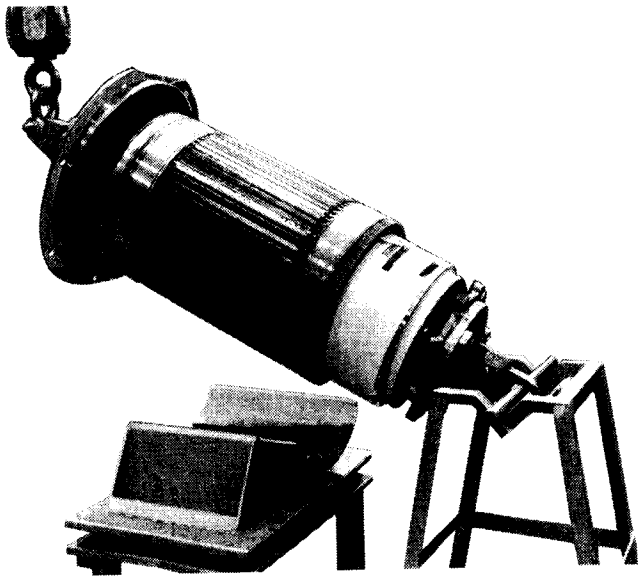
5. On standard shaft armature, apply armature turning plate to the commutator end bearing housing and insert bar through eye in plate, Fig. 37. Use steel stand to lift armature into vertical position and remove turning plate.

6. On through shaft armature, apply commutator end lifting eye to the commutator end of the armature shaft and insert bar through eye, Fig. 38. Use steel stand to lift armature into vertical position and remove lifting eye.



16867

Fig.37 - Raising Standard Shaft Armature For Installation Into Stator



23877

Fig.38 – Raising Through Shaft Armature For Installation Into Stator

7. Cover armature commutator with a strip of protective paper 2 mm x 180 mm x 1 375 mm (1/16" x 7" x 54") to prevent possible damage to commutator as commutator passes brush holders.

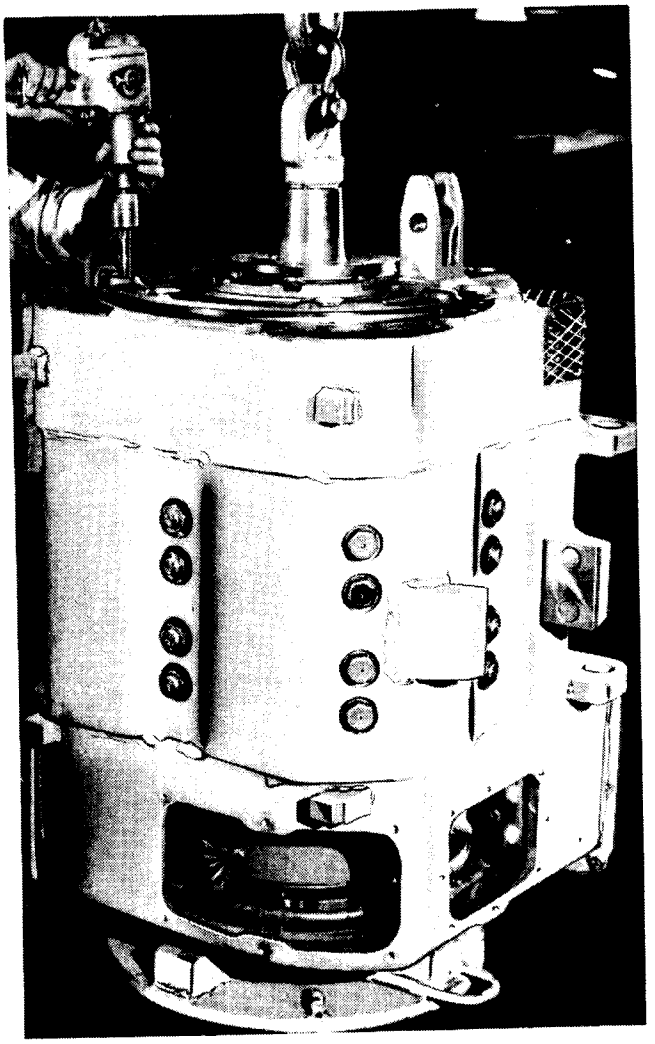
8. Center the armature over the coupling end stator bore and lower armature slowly into the stator. Guide the armature from the top of the stator past the coils. Carefully position the line-up studs through the inspection opening at the commutator end of the frame.

**WARNING**

Keep hands out of the way of the armature housing and the brush holders.

9. Lower armature into stator until line-up studs are about to contact the stator. Line up the commutator housing cap screw holes with the stator holes.

10. Remove the coupling end guide pins and install coupling end housing bolts and lockwashers, Fig. 39. Equally space three 19 mm (3/4") spacer blocks between the coupling end housing and the bore face. Tighten the coupling end housing bolts evenly until the housing contacts the spacer blocks. Rotate the armature while housing bolts are being tightened to make sure the bearings do not bind. Binding can cause damage to bearings. Remove the three spacer blocks.



10071

Fig.39 – Securing Coupling End Housing To Stator Frame

11. Remove the traction motor from the assembly stand, using the coupling end lifting eye, and place traction motor in a vertical position on the floor. Using the upper lifting eyes of the traction motor frame, lower the traction motor into a horizontal position. Lift the traction motor and set on a stand so that the coupling end of the traction motor is 75 mm to 100 mm (3" to 4") higher than the commutator end. This is done to keep armature clearance in one direction.

12. Remove commutator end bearing guide pins and install commutator end bearing housing to frame bolts. Carefully tighten coupling end and commutator end bearing housing to frame bolts evenly. Ensure housings are drawn in evenly and not cocked, keeping the commutator end bearing housing slightly ahead of the coupling

end bearing housing so that the commutator outer race will at no time be forced out of position in the housing. Torque commutator end bearing housing to frame bolts to 366 N·m (270 ft-lbs) and torque coupling end bearing housing to frame bolts to 800 N·m (590 ft-lbs).

13. On standard shaft armatures, such as Fig. 31, assemble commutator end thrust collar and bearing retainer plate. Use a new thrust collar when a new commutator end bearing is used. Torque commutator end thrust collar and bearing retainer plate to 68 to 75 N·m (50 to 55 ft-lbs) to pull bearing into proper position. Assemble commutator end bearing cover with gasket and tighten until lockwashers are set. Torque commutator end and coupling end bearing cover to bearing housing bolts to 170 to 190 N·m (125 to 140 ft-lbs).

14. On through shaft armatures, such as Fig. 32, commutator end bearing must be positioned by assembling thrust collar (where used), outer seal, and tightening locknut. Use a 5″ spanner wrench and sledge hammer to tighten locknut.

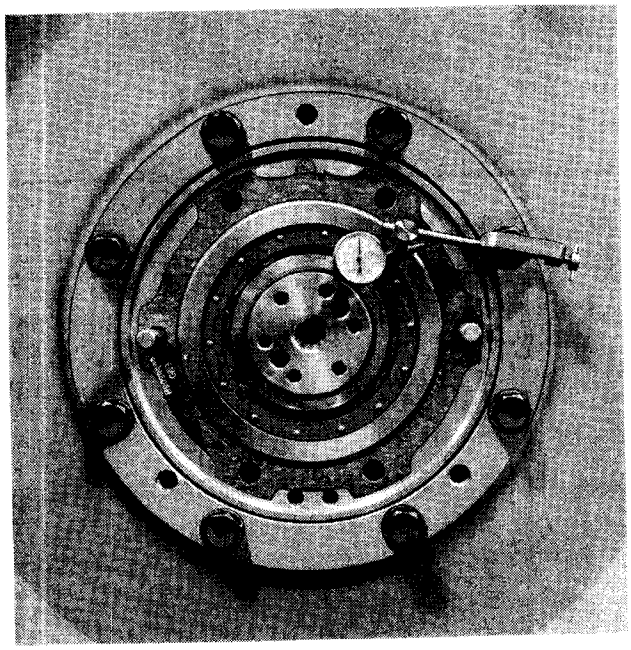
15. On standard shaft armatures, remove the commutator end bearing cover, bearing retainer plate, and thrust collar. On through shaft armatures, remove locknut, outer seal, and thrust collar (where used). Use a 5″ spanner wrench and sledge hammer to remove locknut.

16. Clamp an indicator to the frame and check runout of the bearing race inner face, Fig. 40. Maximum runout should not exceed 0.038 mm (.0015″) of total indicator reading. If runout exceeds 0.038 mm (.0015″), the inner race must be aligned. Usually this will require removing the bearing assembly from the armature, checking the runout of the inner spacer face and reinstalling the bearing assembly.

17. Check the internal radial clearance between the bearing inner race and rollers by passing a feeler gauge blade under the unloaded rollers at one point. The minimum internal radial clearance after assembly should be 0.064 mm (.0025″) when motor is in normal position.

18. Check the internal radial clearance with the lead side of the motor or generator up. With the motor in this position, the absolute minimum clearance shall be 0.05 mm (.002″). If the clearances are lower, check for tight cage or misalignment.

19. On regular shaft armature, reassemble commutator end bearing thrust collar and bearing retainer using six 9420945 7/16″-20 bolts. Ensure these special bolts are used. Torque bolts in a criss-cross pattern to 68 - 75 N·m (50 - 55 ft-lbs).



9086

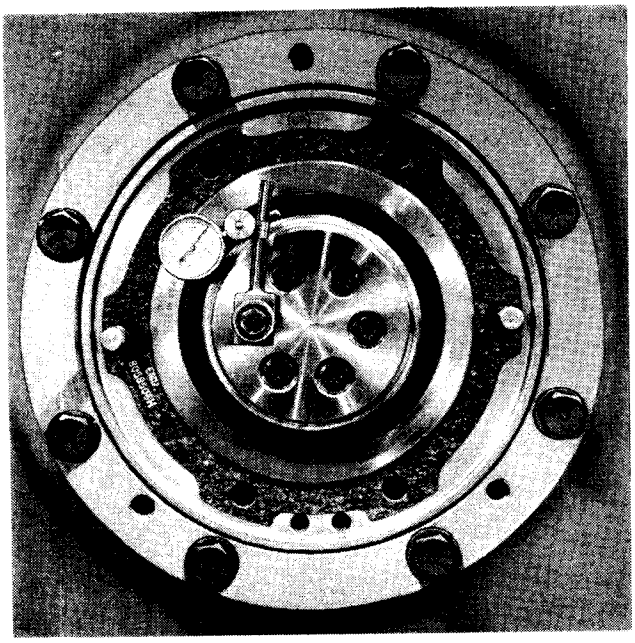
Fig.40 – Checking Alignment Of Commutator End Inner Race

20. On through shaft armature, reassemble commutator end thrust collar (where used), outer seal, and locknut. Use a 5″ spanner wrench and sledge hammer to tighten locknut.

21. On standard shaft armature, remove one of the bearing retainer plate bolts and mount indicator as shown in Fig. 41. On through shaft armature, a magnetic base indicator will have to be mounted to the shaft. Check runout of bearing outer face. Maximum runout should not exceed 0.064 mm (.0025″) total indicator reading. If outer race is out-of-square beyond 0.064 mm (.0025″), check the runout of the commutator end housing face and align end housing if required and recheck outer race. Do not force outer race against the inner bearing cap to align outer race.

22. Position the dial indicator on the bearing outer race.

23. Take up all the bearing end play by pressing on the coupling end lifting fixture (applied to the shaft) with a 450 to 600 mm (18 to 24″) steel bar. Set the dial indicator to "0" and pull the shaft towards the coupling end until shaft comes to a definite stop. The end play should be 0.140 mm to 0.350 mm (.0055″ to .0138″).



9085

Fig.41 - Checking Alignment Of Commutator End Outer Race

Do not force the shaft for this measurement. The commutator end outer race can be shifted or the thrust flanges can be sprung with sufficient force to obtain an erratic indication. If greater than 0.350 mm (.0138″), check the commutator end bearing retainer and thrust collar for tightness, and check the thrust collar for wear.

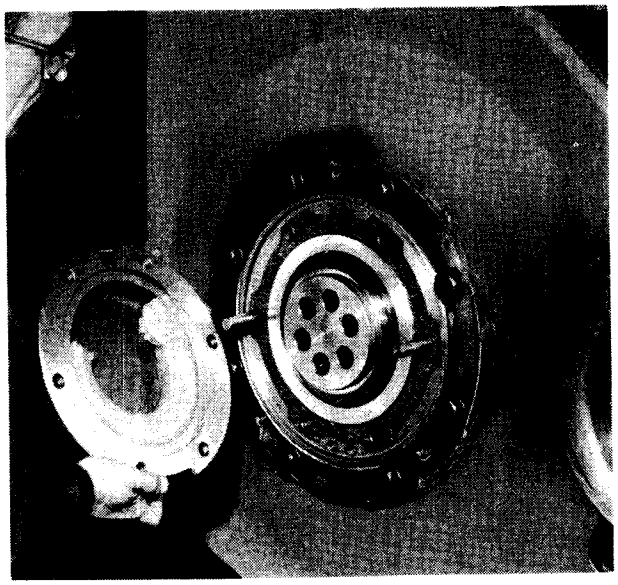
24. Apply grease to the commutator end bearing cover. Refer to Grease Application To Bearing Covers And Caps procedure of this Maintenance Instruction.

25. Inspect bearing cover gasket. If damaged, install a new gasket.

26. Install commutator end bearing cover. Ensure grease arc is at lower portion of cover, Fig. 42. Torque bolts evenly in the sequence 1-3-5-2-4-6, Fig. 43, to 170 to 190 N·m (125 to 140 ft-lbs).

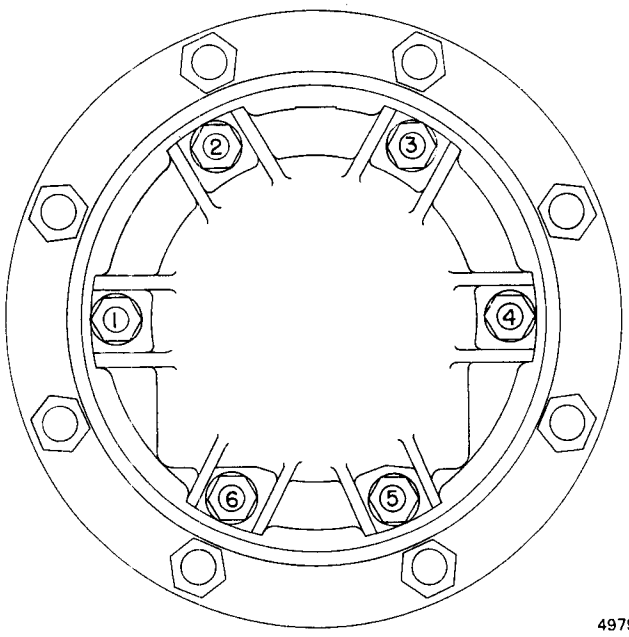
27. Remove coupling end bearing cover. Clamp a dial indicator to the frame and check runout of the bearing inner race face.

    Maximum runout should not exceed 0.038 mm (.0015″). If runout is greater than 0.038 mm (.0015″), the inner race must be aligned Usually this will require removing the bearing assembly from the armature and reinstalling the bearing assembly properly.



7751

Fig.42 - Applying Commutator End Bearing Cover

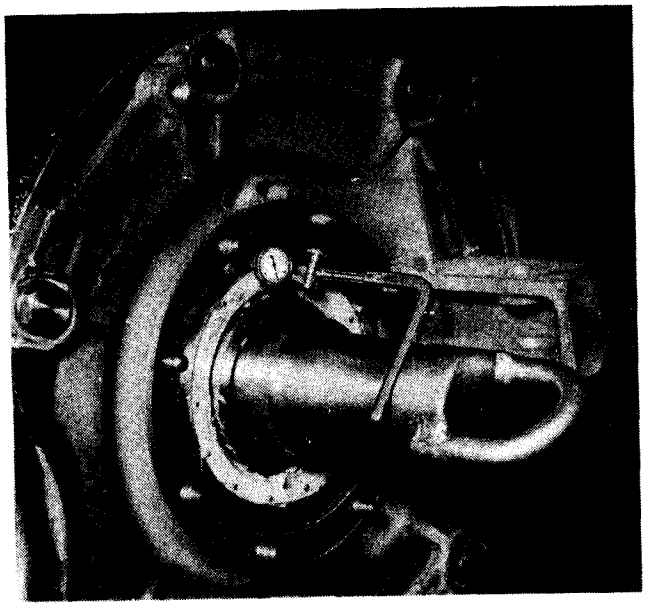



4979

Fig.43 - Commutator End Bolt Numbering

28. Clamp a dial indicator on the armature shaft to check the runout of the coupling end bearing outer race face, Fig. 44. Maximum runout should not exceed 0.08 mm (.003″) of total indicator reading.

29. When motor is in normal horizontal position, check internal radial clearance between the bearing inner race and rollers by passing a feeler gauge blade under the unloaded rollers at one point. The minimum internal radial clearance after assembly shall be 0.08 mm (.003″).



4329

Fig.44 - Checking Alignment Of Coupling End Outer Race

30. Check the internal radial clearance with the lead side of the motor or generator up. With the motor in this position, the absolute minimum clearance shall be 0.05 mm (.002″).

31. Shrink the coupling end outer grease slinger (outer oil thrower on motors manufactured prior to late 1975) to the shaft and hold it against the bearing inner race, rotating the grease slinger until it seizes to the shaft.

32. Apply grease to the coupling end bearing cover. Refer to Grease Application To Bearing Covers And Caps procedure of this Maintenance Instruction.

33. Inspect bearing cover gasket. If damaged install new gasket.

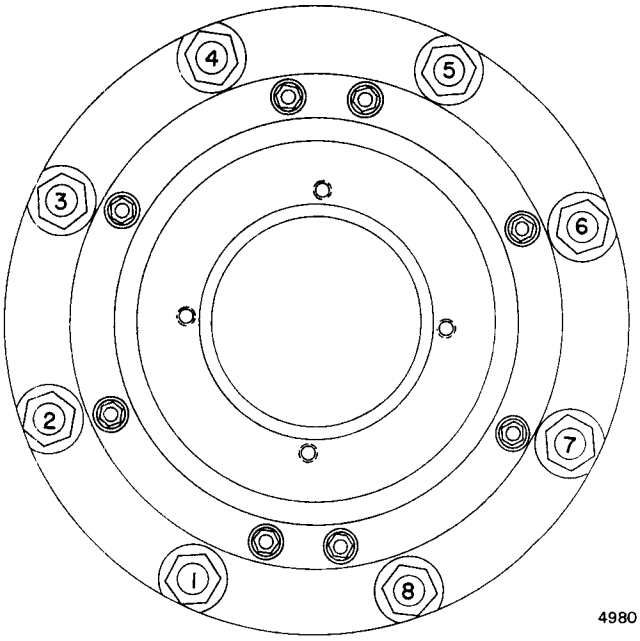
34. Install coupling end bearing cover. Ensure grease arc is at lower portion of cover. Torque bolts evenly in the sequence 1-3-5-7-2-4-6-8, Fig. 45, to 170 to 190 N·m (125 to 140 ft-lbs).

35. On through shaft type bearing assembly, Fig. 32, perform the following:

    a. Remove locknut (7) from shaft.

    b. Apply a new lockwasher (8) to shaft.

    c. Apply locknut (7) to shaft and tighten, using a 5″ spanner wrench and sledge hammer. Pound ears of lockwasher (8) down tightly on locknut flats.




4980

Fig.45 - Coupling End Bolt Numbering

    d. Heat drive hub (11) to 128° C (230° F) over room temperature and apply to shaft. Do not exceed 191° C (375° F). Assemble retainer plate (10) and tighten retainer plate bolts while drive shaft is still hot. Retighten bolts when drive hub is cold.

    e. Assemble guard (9).

36. On stub shaft type bearing assembly, Fig. 33, perform the following:

    Regular Shaft

    a. Bolts stub shaft (7) to armature shaft.

    b. Assemble guard (8) to stator frame.

    Through Shaft

    a. Remove locknut (19) from shaft.

    b. Apply a new lockwasher (16) to shaft.

    c. Apply locknut (19) to shaft and tighten, using a 5″ spanner wrench and sledge hammer. Pound ears of lockwasher (16) down tightly on locknut flats.

    d. Heat drive hub (15) to 128° C (230° F) over room temperature and apply to shaft. Do not exceed 191° C (375° F). Assemble stub shaft (14) and tighten stub shaft bolts while drive hub is still hot. Retighten bolts when drive hub is cold.

    e. Assemble guard (13) to stator.

37. On vertical mounted through shaft type bearing assembly, Fig. 34, perform the following:

    a. Remove locknut (13) from shaft.

    b. Shrink bearing outer seal (12) to shaft. Ensure seal is tight against bearing inner race.

    c. Apply a new lockwasher (15) to shaft.

    d. Apply locknut (13) to shaft and tighten, using a 5" spanner wrench and sledge hammer. Pound the ears of lockwasher (15) down tightly on locknut flats.

    e. Bolt shield (14) to locknut (13).

38. Remove protective paper cover from commutator and adjust brush holders so that the bottom faces of the brush slots are 3 to 5 mm (1/8" - 3/16") above the commutator surface. Torque brush holder clamp bolts to 200 - 220 N·m (150 - 160 ft-lbs) after obtaining clearance.

39. Install brushes to brush holders. If old brushes are to be used, they should be installed in the same position in brush holder from which they were removed. When new brushes are installed, they must be "sanded in" by wrapping 1-1/2 turns of medium gauge sandpaper (with the abrasive side out) around the commutator before the brushes are applied. Install brushes and rotate armature until all the brushes are seated.

40. If new brushes were sanded in, remove sandpaper and blow out carbon dust with clean, dry compressed air at reduced pressure. Use a clean, dry, bound-edge cloth to remove carbon from string band and commutator riser while manually rotating the armature. Wipe carbon dust from brush holder insulators.

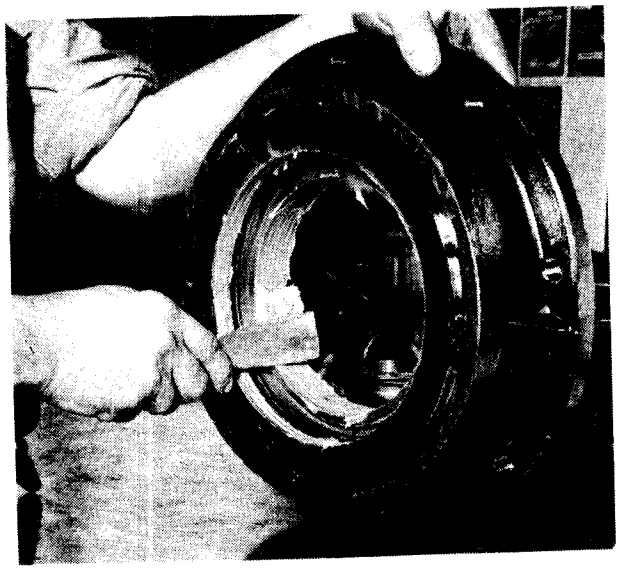
41. Connect brush shunts to brush holders. Torque bolts to 15 - 20 N·m (10 - 15 ft-lbs).

# GREASE APPLICATION TO BEARING CAPS AND COVERS

**NOTE**

For sealed grease type bearings use Shell Cypring RA Grade 3 grease. For additive grease type bearings use Lubrico M6. Refer to Service Data for grease type and part number.

1. Fill all labyrinth grooves in the bearing caps and covers flush with grease, as shown in Fig. 46. This grease need not be measured.



7762

Fig.46 – Grease Application To Labyrinth Grooves

**NOTE**

Depending upon the model, not all bearing caps and covers have labyrinth grooves.

2. For additive grease type bearings, fill grease pipe and grease groove in the bearing and bearing housing with grease.

3. Weigh the piece of paper that will be used in handling the grease to fill the bearing cap and cover. Weight of paper must be compensated for when weighing grease.

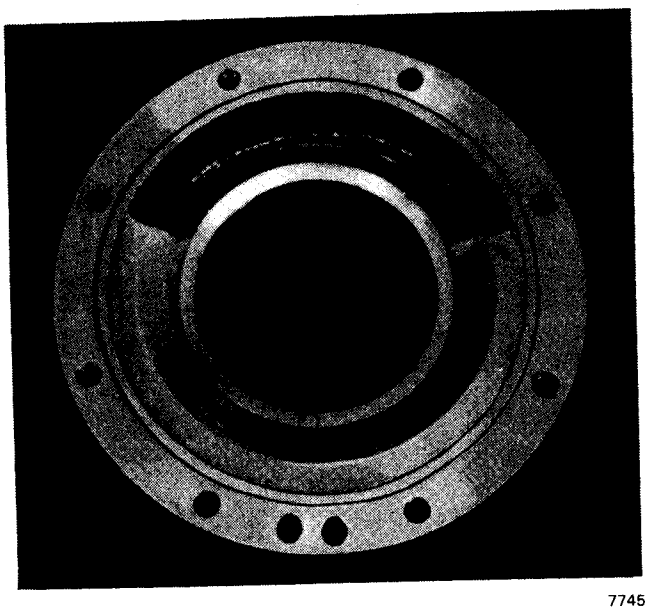
4. Carefully weigh grease for specific bearing end to be greased. Refer to Service Data for proper quantity.

**NOTE**

When anti-churn insert is used with the bearing cap, it is recommended that about two thirds of the weighed grease be applied to the cavity. Then push insert into grease and apply the four locating buttons on the insert into four locating holes in the cap. Finish off grease contour using the balance of the weighed grease.

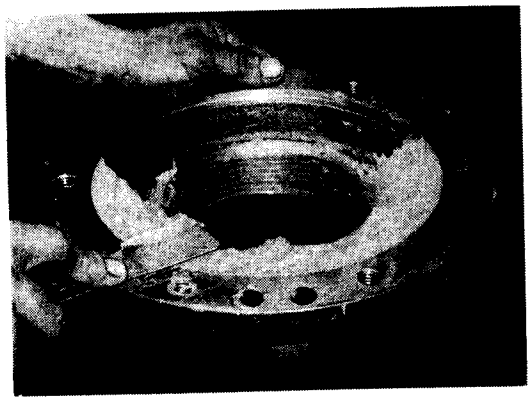
5. Pack grease solidly into the lower portion of the cap. Keep the ungreased portion at the top of the bearing cap as shown in Fig. 47. The bottom of bearing cap has two drain holes.

6. Using a spatula or putty knife, roughly form the grease into the approximate desired contour, Fig. 48, and apply correct grease mask as determined from Service Data. The grease arc must be packed without air voids.



7745

Fig.47 - Grease Position



7764

Fig.48 - Roughly Formed Grease Contour

7. Rotate grease mask to form proper contour, keeping mask seated as shown in Fig. 49. Several turns may be required to get proper contour. Use spatula or putty knife to fill in low spots with grease from the mask blade. The small amount of grease retained on the blade should be removed and applied to the ends of the grease arc. The contour should be built up to the limits of Fig. 50.

7748A

Fig.49 - Application Of Grease Mask

**NOTE**

Bearing caps or covers without labyrinth grooves or inner lip use identical grease contour.

8. Remove roller cage assembly from bearing outer race. Work grease into the outside diameter of the roller cage assembly with a putty knife or spatula, Fig. 51, coating the rollers and spreading grease into the cage pockets. Use full amount specified for bearing. Apply some grease between the roller ends and cage end rings. Apply a continuous light coat of grease on the inner race roller paths before assembly of outer race and roller assembly.

9. Replace roller cage in outer race and work grease around the inside diameter of rollers and into the cage pockets.

**CAUTION**

In removing and replacing roller cage assembly from bearing outer race, ensure cage and outer race are handled squarely to prevent gouging or deforming cage bars on outer race.

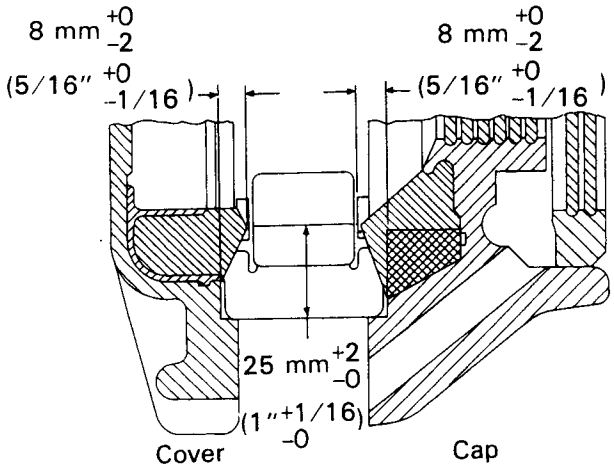
## DRIVE FLANGE OR COUPLING

A drive flange or coupling provides a means of coupling the motor or generator to a device that it is to drive or be driven by, depending on its application. All references to the drive flange in the following removal and application procedures can be interpreted as couplings in those applications that are so equipped.

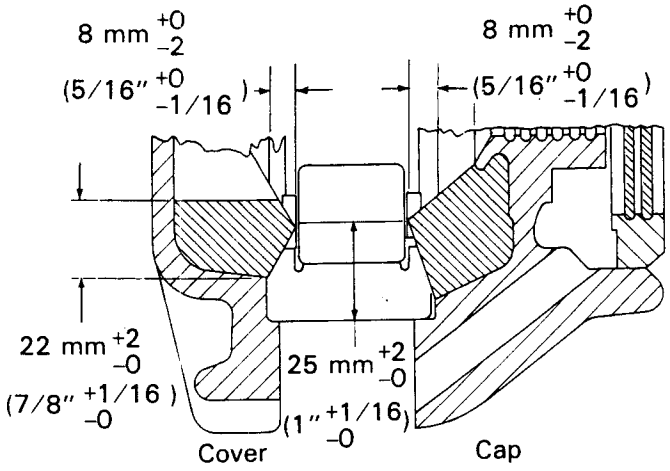
The drive flange is heated and shrunk onto the armature shaft to provide the fit necessary to withstand the strain imposed in operation. The drive flange is removed either by pulling off with a hydraulic puller or by "floating off" by means of hydraulic pressure. Refer to Service Data for special equipment required for drive flange removal. The drive flange is removed as follows.

## DRIVE FLANGE REMOVAL WITH HYDRAULIC PULLER

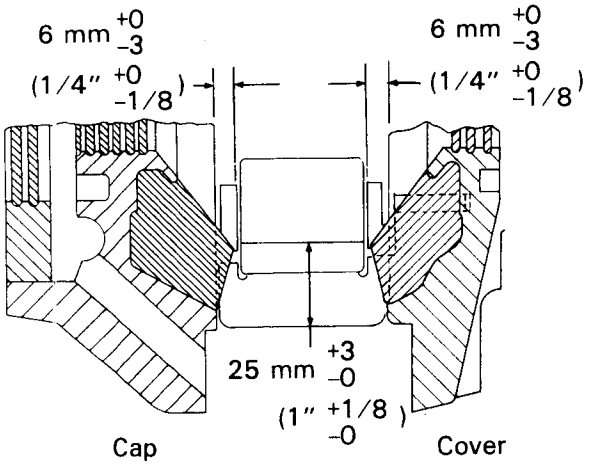
1. Remove the retaining nut from end of armature shaft with an air impact wrench, Fig. 52, or with a retaining nut wrench and handle.



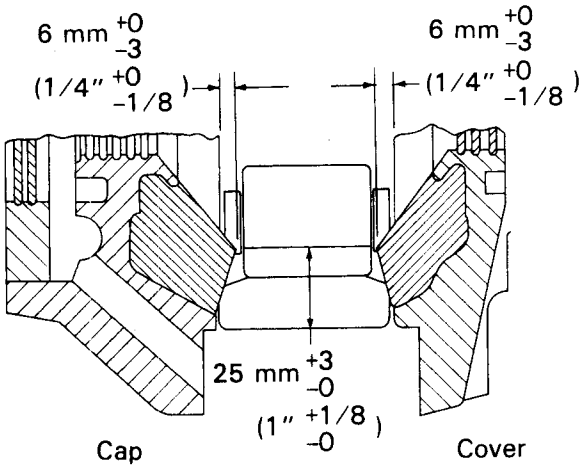

COMMUTATOR END, ROLLER BEARING
WITH ANTI-CHURN INSERT



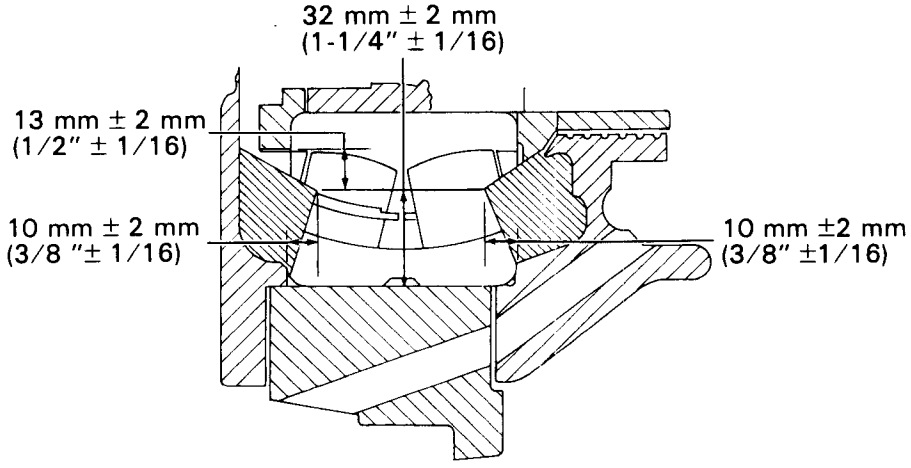

COMMUTATOR END, ROLLER BEARING
WITHOUT ANTI-CHURN INSERT




COUPLING END, ROLLER BEARING
WITH ANTI-CHURN INSERT



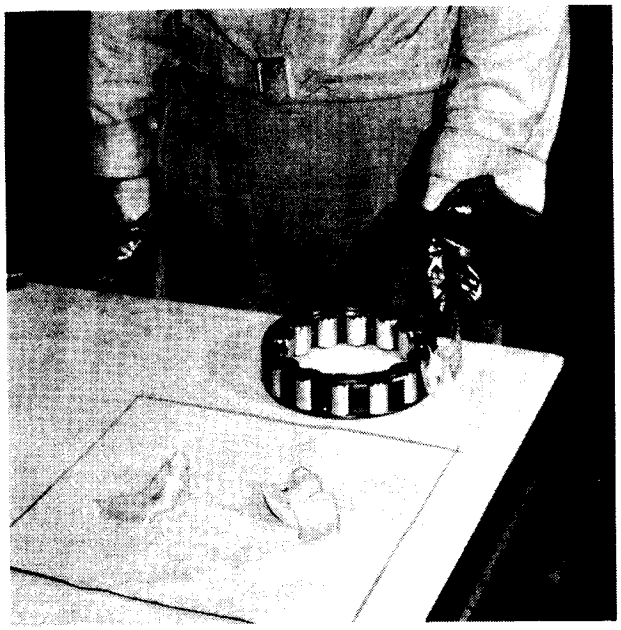

COUPLING END, ROLLER BEARING
WITHOUT ANTI-CHURN INSERT




COMMUTATOR END, SPHERICAL
ROLLER THRUST BEARING

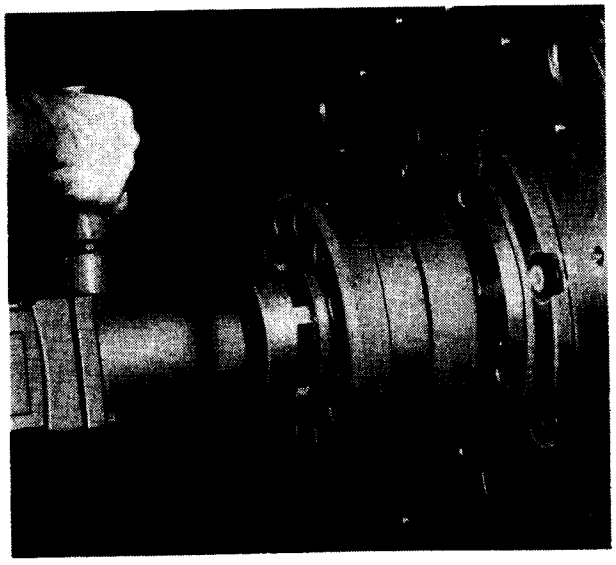
26236

Fig.50 - Grease Contour



7749

Fig.51 – Coating Outside Diameter Of Roller And Cage Assembly



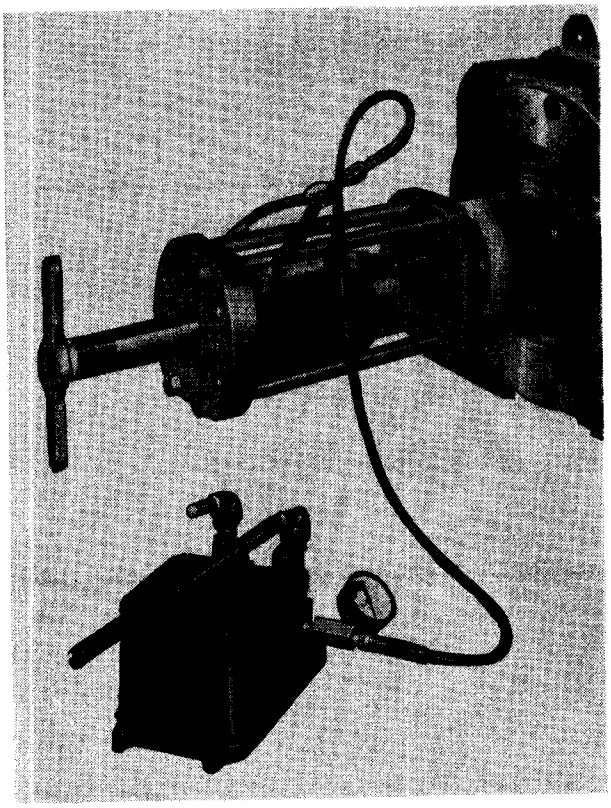
14537

Fig.52 – Removing Retaining Nut

2. Clean threads in drive flange and in pulling pilot.

3. Apply spacer between the end of the armature shaft and the ram of the puller to protect the shaft from possible damage.

4. Install threaded pilot and hydraulic puller assembly using a suitable hoist, Fig. 53. The threaded pilot should enter the threaded portion of the drive flange to its complete depth so threads will not strip.



8372

Fig.53 – Hydraulic Drive Flange Puller

**WARNING**

Remove hoist before attempting to pull drive flange. Drive flange releases suddenly and if left suspended on hoist can swing violently.

Clear area in line with drive flange to avoid damage to equipment or injury to personnel when drive flange releases.

5. Pump hydraulic drive flange puller to build up pressure and remove drive flange.

## DRIVE FLANGE REMOVAL BY FLOAT-OFF METHOD

The float-off method of drive flange removal can be used on armature shafts which are manufactured with a groove around the shaft taper which is connected by drilled passages to a 1/2"-20 tapped hole in the center of the shaft, as shown in Fig. 54. The drive flange is removed by applying high pressure oil through the drilled passages to the inside of the drive flange bore which results in the drive flange being released from the shaft.

1. Loosen the nut on end of armature shaft with an air impact wrench, Fig. 52, or with a retaining nut wrench and handle approximately one turn, but do not remove.

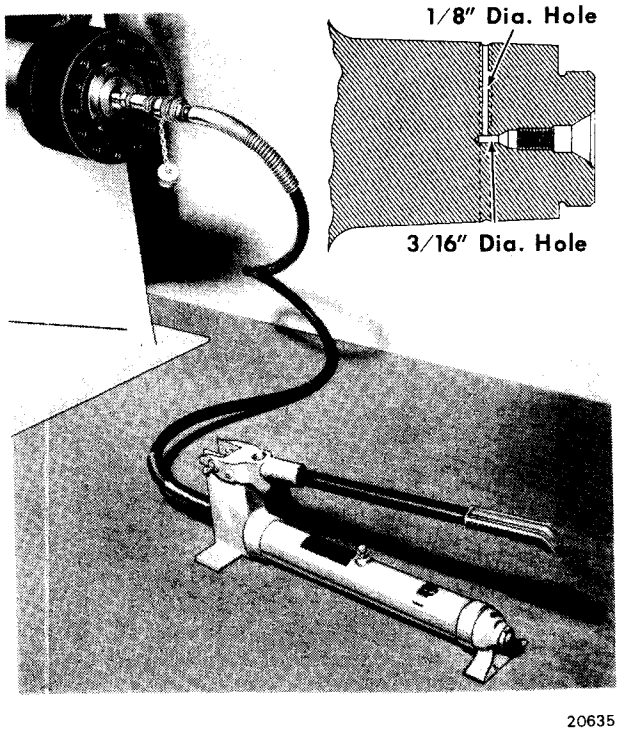



Fig.54 - Drive Flange Float-Off Removal

2. Clean the center of the armature shaft and remove the 1/2"-20 socket head setscrew. Ensure that threads and pressure fitting seat are clean.

3. Screw adapter nipple into shaft and tighten to 34-41 N·m (25-30 ft-lbs). Do not overtighten as this will damage the shaft seat.

4. Connect adapter nipple to the hydraulic pump with the high pressure hose assembly. Close screw on the pump and operate lever to build up pressure. When pressure becomes high enough, drive flange will be released from armature shaft and will move off against the retaining nut. Remove retaining nut and remove drive flange.

5. Remove equipment and replace setscrew in end of shaft.

## DRIVE FLANGE APPLICATION

It is essential that the drive flange is properly mounted on the armature shaft to ensure it is fit with the proper tightness. Apply the drive flange as follows:

**NOTE**

The following procedure applies to EMD supplied coupling or drive flange.

1. Remove any burrs or scoring on armature shaft or in drive flange bore by honing or cleaning away with Arkansas stone (novaculite) or with abrasive cloth no coarser than 320 grit.

2. Clean threads on armature shaft with a wire brush, or if threads are damaged, run on a thread chasing die. Apply retaining nut to shaft to check for proper fit.

3. Thoroughly clean drive flange bore and tapered end of armature shaft where drive flange will be mounted. The slightest bit of lint or dirt will hinder drive flange application.

4. Check the contact between the drive flange and shaft taper as follows:

   a. Apply a thin, even coat of Prussian (non-drying) bluing compound to the drive flange bore with the fingers. A cloth should not be used since heavy deposits of bluing will not allow a true indication of fit.

   b. Place the drive flange on the shaft carefully, avoiding undue rubbing. With the drive flange held snug on the shaft, rotate drive flange approximately one-eighth turn and back. Remove the drive flange carefully and inspect the amount of bluing transferred to the shaft and the areas of contact.

      It is necessary that the drive flange is in firm contact with the small end of the armature shaft taper. A 50% contact is expected, but if the two tapers are at opposite extremes of tolerance, it is required that the drive flange is in firm contact with at least 20% at the small end of the armature shaft taper. The large end of the bore should not contact unless a line-to-line contact is obtained throughout the bore.

   c. If correction is required, polish the shaft with Arkansas stone (novaculite) or with abrasive cloth no coarser than 320 grit.

   d. Thoroughly clean and remove all traces of bluing from the shaft and drive flange with a solvent and wipe dry with clean, disposable tissues.

5. With armature shaft and drive flange at room temperature, lightly mount drive flange on shaft to ensure proper alignment. Withdraw drive flange about 13 mm (1/2") and then using both hands, push firmly in place as far as it will go. Ensure drive flange is mounted squarely on shaft.

6. Measure and record drive flange position with respect to the shaft with a micrometer depth gauge. Refer to Service Data for drive flange advance depth gauge part number.

7. Mark the points of measurement on the drive flange, then mark the end of the shaft and drive flange to retain the same angular relationship when re-applying and for final installation.

8. Remove drive flange. If this proves difficult, small steel wedges may be used between the drive flange and the frame. To prevent damage to the bearing housing, a strip of copper should be placed between wedge and housing.

9. Repeat Step 5, using the mating marks previously made to ensure proper relationship of drive flange and shaft.

10. Apply micrometer depth gauge to markings and again measure and record drive flange position on the shaft. Compare readings to those previously taken in Step 6. A minimum of two such readings should be made to determine variations, if any, in readings. To be acceptable for final mounting, successive cold readings should not vary more than 0.08 mm (.003″).

    If variation exceeds these limits, again carefully clean drive flange bore and armature shaft to eliminate all possibility of dirt or contamination. If the variation is as much as 0.25 mm (.010″), the drive flange fit to armature shaft must be checked by bluing and corrections made by lapping. It is necessary that the drive flange is in firm contact with at least 20% at the small end of the armature shaft taper. The large end of the bore should not contact unless a line-to-line contact is obtained throughout the bore.

11. When cold mounting variations are within limits, the drive flange may be heated with an induction heater, Fig. 55, for final mounting. Heat and mount the drive flange as follows:

    a. Heat drive flange to the temperature specified in the Service Data. Check temperature at various points on the drive shaft with a hand pyrometer. Take readings ONLY when current to the induction heater is turned off. Drive flange temperature should NEVER exceed 190° C (374° F).

**NOTE**

Since a change of 1° C is equivalent to a change of 1.8° F, a 121° C rise in temperature is therefore equivalent to a rise of 218° F.

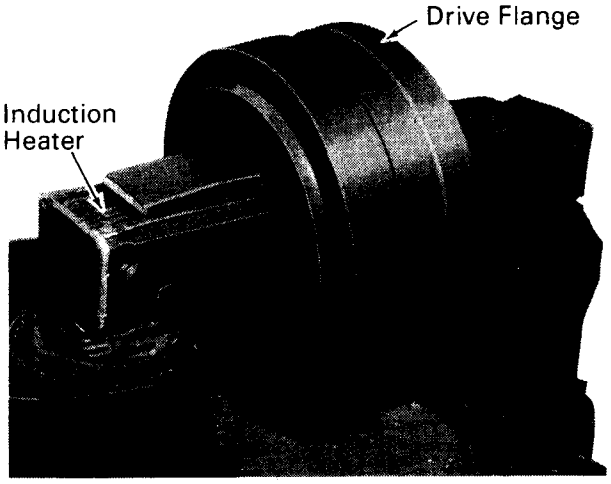



Fig.55 – Induction Heater

As an example of proper heating, assume the shaft temperature is 24° C (75° F). The drive flange should then be heated to obtain 145° C (293° F), which is the desired 121° C (218° F) rise in temperature over that of the shaft.

    b. When drive flange is heated to the proper temperature, mount the hot drive flange on the shaft in the same position used for the cold mountings.

    c. Measure drive flange position with respect to the shaft with a micrometer depth gauge. Refer to Service Data for proper drive flange advance on the shaft over the previous cold reading. Drive flange advance is the difference between the final and the cold measurements.

    d. If drive flange advance is not within specified limits in Service Data, drive flange will have to be removed and the procedure repeated after parts have cooled to room temperature.

    e. Place the drive flange retaining nut into the cup lockwasher.

**NOTE**

In Step f, reused drive flange retaining nut should be checked for flatness prior to assembly, using a straightedge and feeler gauge. The dish, if any, should be noted so an additional 0.10 mm (.004″) dish can be determined in Step f.

    f. After final correct mounting of the heated drive flange, quickly tighten the drive flange retaining nut (with cup lockwasher) before the shaft and drive flange temperatures equalize. Check for tightness of the nut 10

minutes after application, by measuring nut dish 6.4 mm (1/4") from inside the chamfer, using a straightedge and feeler gauge. A minimum dish of 0.10 mm (.004") is necessary.

g. Secure the drive flange retaining nut by staking the cup lockwasher into the two notches in the drive flange and stake the cup lockwasher into two notches of the retaining nut.

## STATOR FRAME

The stator frame is a fabricated structure containing main poles, interpoles, and the brush holder assemblies. Between overhaul periods, the stator should be kept clean by blowing out dust and dirt at regular intervals. Periodic cleaning will prevent undesirable accumulations from forming.

## CABLES AND CONNECTORS

The motor and generator leads are equipped with clasp type connectors consisting of two machined brass couplings as shown in Fig.56. Considerable force is necessary to make up or disconnect these fittings and a special tool, Fig. 57, is available for this purpose. Refer to Service Data for part number.

No lubrication is required on these connectors and no maintenance is required if the recommended tool is used. Do not strike connectors with a hammer. If proper tool is not available, a wood block should be used to protect the connector from damage.

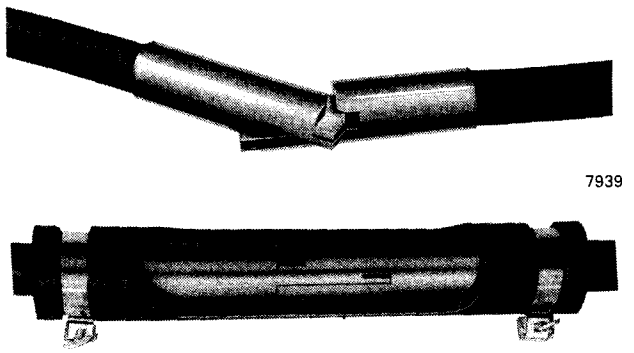



Fig.56 - Clasp Type Connectors


Fig.57 - Motor Lead Breaker

# SERVICE DATA

## SPECIFICATIONS

### D39, D49, D59 BRUSHES - With Coil Spring (Adjustable) Brush Holder

| | Part No. |
|---|---|
| Two wafer, flat top<br>54 mm x 51 mm x 16 mm<br>(2-1/8″ x 2″ x 5/8″)<br>Grade DE-5 | 8215949 |
| Two wafer, flat top<br>56 mm x 51 mm x 16 mm<br>(2-3/16″) x 2″ x 5/8″)<br>Grade AC-124 | *9322055 |
| Two wafer, flat top<br>56 mm x 51 mm x 16 mm<br>(2-3/16″ x 2″ x 5/8″)<br>Grade DE-7 | *9322056 |

*Multiple Wear Lines

### D39, D49, D59 BRUSHES - With Constant Pressure Brush Holder

| | |
|---|---|
| Two wafer, with resilient pad<br>56 mm x 51 mm x 16 mm<br>(2-3/16″ x 2″ x 5/8″) | |
| Grade DE-7 | *9322054 |
| Grade AC-124 | *9322053 |

*Multiple Wear Lines

| | |
|---|---|
| Three wafer, with resilient pad and floating center wafer<br>54 mm x 51 mm x 16 mm<br>(2-1/8″ x 2″ x 5/8″)<br>Grade DE-7 | 8403347 |

### D69, D79, M79, G79, M89, G89 BRUSHES

| | |
|---|---|
| Three wafer, with resilient pad and floating center wafer<br>62 mm x 51 mm x 16 mm<br>(2-7/16″ x 2″ x 5/8″) | |
| Grade AC-124 | *9322057 |
| Grade DE-7 | *9322058 |
| Grade AC-100 | *9322059 |

*Multiple Wear Lines

| | |
|---|---|
| BRUSH WEAR LIMIT | Replace when spring pressure arm is 3 mm (1/8″) above brush box |

## BRUSH HOLDERS

| | |
|---|---|
| Number of brush holders | 4 |
| Clearance – bottom of brush holder to commutator | Min. 3.2 mm (1/8″)<br>Max. 4.8 mm (3/16″) |
| Spring Pressure | |
| Adjustable type | Min. 3.2 kg (7 lbs)<br>Max. 4-5 kg (9-11 lbs) |
| Constant pressure type | |
| New | Min. 1.8 kg (4 lbs)<br>Max. 2.3 kg (5 lbs) |
| Used | Min. 1.6 kg (3.5 lbs) |
| Torque Values | |
| 7/8″-9 brush holder block bolt | 203-217 N·m (150-160 ft-lbs) |
| 1/2″-13 brush holder cable to brush holder bolt | 95-102 N·m (70-75 ft-lbs) |
| 5/16″-18 brush shunt screw | 14-20 N·m (10-15 ft-lbs) |

## MOTOR OR GENERATOR WEIGHT (Approximate)

Model M89, G89

| | |
|---|---|
| Complete | 2 658 kg (5860 lbs) |
| Armature | 872 kg (1923 lbs) |

All Other Models

| | |
|---|---|
| Complete | 2 515 kg (5545 lbs) |
| Armature | 821 kg (1810 lbs) |

## AIR GAP (Nominal)

| | |
|---|---|
| Main Pole | 5.94 mm (0.234″) |
| Interpole | 7.24 mm (0.285″) |

## COMMUTATOR

| | |
|---|---|
| Mica groove width | 1.27 mm (0.050″) Max. |
| Mica groove depth | 1.2 mm (3/64″) Min.<br>2 mm (5/64″) Max. |

## DRIVE FLANGE APPLICATION

| Drive Flange Part Number | Approx. Temp. Rise Above Shaft Temp. °C | °F | Drive Flange Advance ±0.13 mm (±.005″) |
|---|---|---|---|
| 8222850 | 110 | 198 | 1.27 mm (.050″) |
| 8261556 | 110 | 198 | 1.27 mm (.050″) |
| 8306779 | 110 | 198 | 1.27 mm (.050″) |
| 8324511 | 110 | 198 | 1.27 mm (.050″) |
| 8221416 | 121 | 218 | 1.40 mm (.055″) |
| 8226704 | 121 | 218 | 1.40 mm (.055″) |

## RESISTANCE (AT 75° C)

**NOTE**

Take interpole resistance between end of brush holder lead AA and right brush holder (facing commutator). Take field resistance between ends of F and FF brush holder leads. Measure cold temperature with thermocouple probe and potentiometer on the commutator.

| | Ohms ± 2% |
|---|---|
| Armature | |
| D79F, D79MC, M79, G79 | 0.01232 |
| D79X3A, D79X3AF | 0.01185 |
| M89 | 0.01190 |
| All Other Models | 0.01446 |
| Series Field Circuit | |
| D39 motor | 0.00951 |
| D49, D59, D69 motor | 0.00870 |
| D79F motor | 0.00886 |
| D79MC, M79 motor | 0.00876 |
| D79X3A motor, D79X3AF motor | 0.00816 |
| M89 motor | 0.007923 |
| Generator Field Circuit | |
| D39 generator | 0.301 |
| D49, D59, D69, D79, G79 generator | 0.842 |
| Interpole Circuit | |
| D39 motor and generator | 0.00736 |
| D49, D59, D69, D79, generator | 0.00647 |
| D49, D59, D69 motor | 0.00645 |
| D79F motor | 0.00785 |
| D79MC, M79 motor | 0.00652 |
| D79X3A, D79X3AF motor | 0.00695 |
| M89 motor | 0.006228 |

## HIGH POT TEST

| | |
|---|---|
| Motors | 2400 volts - 10 sec. |
| Generators | 2400 volts - 10 sec. |
| Separately excited generator fields | 900 volts - 10 sec. |

## SEALED GREASE BEARING LUBRICANT QUANTITY ± 7 g (1/4 oz)

| | COUPLING END | | COMMUTATOR END | |
|---|---|---|---|---|
| | Kilograms | Ounces | Kilograms | Ounces |
| Cover | 0.340 | 12 | 0.170 | 6 |
| Cap | 0.397 | 14 | 0.198 | 7 |
| Roller Cage O.D. | 0.057 | 2 | 0.028 | 1 |
| Roller Cage I.D. | 0.057 | 2 | 0.028 | 1 |
| | 0.851 | 30 | 0.424 | 15 |

## ADDITIVE GREASE BEARING LUBRICANT QUANTITY ± 7 g (1/4 oz)

| | COUPLING END | | COMMUTATOR END | |
|---|---|---|---|---|
| | Kilograms | Ounces | Kilograms | Ounces |
| Cover | 0.340 | 12 | 0.227 | 8 |
| Cap | 0.397 | 14 | 0.227 | 8 |
| Bearing | 0.114 | 4 | 0.198 | 7 |
| | 0.851 | 30 | 0.652 | 23 |

## EQUIPMENT LIST

| | Part No. |
|---|---|
| Grease Masks | |
| Commutator End Cover, Without Insert | 8228023 |
| Commutator End Cover, With Insert | 8252767 |
| Commutator End Cap | 8228024 |
| Coupling End Cap And Cover (built prior to January 1, 1971) | 8228025 |
| Coupling End Cap And Cover (built after January 1, 1971) | File No. 777 |
| Locating Studs - Coupling End Bearing Cap | 8155976 |
| Locating Studs - Commutator End Bearing Cap | 8155977 |
| Lifting Fixture Coupling End Shaft | 8067122 |
| Turing Plate, Commutator End | 8067147 |
| Stand, Traction Motor Frame | 8064917 |
| Rethreading Die, Armature Shaft | 8050721 |
| Die Holder | 8057022 |

# EQUIPMENT LIST (CONT'D)

| | Part No. |
|---|---|
| Brush Spring Lifter | 8140869 |
| Retaining Nut Wrench | 8127529 |
| Sliding "T" Handle | 8127528 |
| Depth Gauge, Drive Flange Advance | 8160273 |
| Brush Slot Gauge | 8259133 |
| Aligning Tool, Brush Holder Spring Cell | 8305181 |
| Adapter, Commutator Grinder (Brush Holder Mounted) | 8354239 |
| Commutator Grinder | 8355891 |
| Grinder Alignment Bar | 8210141 |
| Vacuum Cleaner Blower | 8210140 |
| Dust Collector | 8210142 |
| Grinding Stones, Finish Grade - 2 reqd. | 8201791 |
| Grinding Stones, Medium Grade -2 reqd. | 8496921 |
| Brush Seating Stone (Chalk Stone) | 1A73686 |
| Sandpaper, 220 Grit - 216 mm x 46 m (8-1/2" x 50 yd.) roll, 3 m (10 ft) per unit | 19AB12 |
| Hydraulic Drive Flange Puller Kit | 8309742 |
| Hydraulic Pump | 8302969 |
| Hydraulic Oil, 3.8 litres (1 gal) | 8246430 |
| Hose Assembly | 8327054 |
| Nipple, 1/2"-20 | 8309741 |
| Adapter Nipple, 3/8"-24 | 8302965 |
| Retaining Nut | 8303020 |
| Manual Drive Flange Puller Kit | 8303330 |
| Pulling Plate Assembly | 8168577 |
| Pulling Plate | 8168604 |
| Includes Studs: | |
| 5/8"-11 NC (Commutator End Bearing Cap) | 8168606 |
| 3/8"-16 NC (Coupling End Outer Oil Ring) | 8168611 |
| 5/8"-11 UNC-2A (Coupling End Bearing Cap) | 8204436 |
| Motor Lead Breaker | 8243341 |
| Lifting Eye, Standard Shaft Armature, Commutator End | 8174221 |
| Lifting Eye, Through Shaft Armature, Commutator End | *File No. 906 |

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

# MATERIAL LIST

| | |
|---|---|
| Armature Bearing Lubricant | |
| Sealed Grease Bearing - Shell Cyprina RA Grade 3 | |
| 15.9 kg (35 lb) Pail | 8249819 |
| 54.4 kg (120 lb) Drum | 8249820 |
| Additive Grease Bearing - Lubrico M6 | |
| 4.5 kg (10 lb) Pail | 8102584 |
| 11.3 kg (25 lb) Pail | 8068104 |
| 54.4 kg (120 lb) Drum | 8102808 |
| Solder | |
| Pure Tin, 7.3 kg (16 lbs) | 8069984 |
| 50% Tin, 50% Lead, 0.7 kg (1.5 lb) | 8225762 |
| 63% Tin, 37% Lead | 8004403 |

# MATERIAL LIST (CONT'D)

| | |
|---|---|
| Flux, Soft Solder, 0.45 kg (1 lb) | 8122570 |
| Flux, Brazing, 0.45 kg (1 lb) | 8116442 |
| Brazing Alloy, 15% Ag, 5% P, 80% Cu, 2.27 kg (5 lbs) | 8122284 |