

**TECHNICAL MANUAL**

**DIRECT SUPPORT AND GENERAL SUPPORT**

**MAINTENANCE MANUAL**

**(INCLUDING REPAIR PARTS**

**AND SPECIAL TOOLS LIST)**

**STARTER, ENGINE, ELECTRICAL**

**LEECE-NEVILLE MODEL M0017072MB**

**(2920-00-267-9987)**

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**HEADQUARTERS, DEPARTMENT OF THE SSARMY**

**MAY 1975**



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NO. 1

HEADQUARTERS  
DEPARTMENT OF THE ARMY  
Washington, D.C., 19 September 1994

**DIRECT SUPPORT AND GENERAL SUPPORT  
MAINTENANCE MANUAL  
(INCLUDING REPAIR PARTS  
AND SPECIAL TOOLS LIST)  
FOR**

**STARTER, ENGINE, ELECTRICAL  
LEECE-NEVILLE MODEL M0017072MB  
(2920-00-267-9987)**

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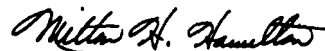
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Current as of 4 December 1974

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\*This manual supersedes TM 9-2920-243-34, 21 March 1972.

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# CHAPTER 1

## INTRODUCTION

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### Section I. GENERAL

#### 1-1. Scope

This manual is for your use in maintaining the Electrical Engine Starter Assembly, Leece-Neville Model M0017072MB (2920-00-267-9987) (fig. 1-1).

#### 1-2. Maintenance Forms and Records

Maintenance forms and records that you are required to use are explained in TM 38-750.

#### 1-3. Reporting of Errors

You can improve this manual by calling attention to errors and by recommending improvements using DA Form 2028 (Recommended Changes to Publications and Blank Forms) or by a letter and mail direct to Commander, US Army Tank-Automotive Command, ATTN: AMSTA-MSP, Warren, MI 48090. A reply will be furnished direct to you.

### Section II. DESCRIPTION AND DATA

#### 1-4. Description

This electrical starter is a heavy duty, 24-volt, insulated, waterproof, fungus and corrosion resistant, solenoid operated, enclosed shift-lever type with eight brushes retained in four brush holders. The drive assembly is a heavy duty, overrunning type and the pinion clearance is adjustable. The starter assembly consists of eight major components, These are the brush rigging assembly, shift housing assembly, shaft and lever assembly, pinion housing assembly, drive assembly, armature assembly, and field ring assembly.

#### 1-5. Tabulated Data

Voltage . . . . .	24vdc
Current at rated load (rated max) . . . . .	.500 amps
Horsepower (rated) . . . . .	8.5 hp at 2550 rpm
Stall torque . . . . .	.106 lbs-ft
Pinion rotation (facing drive end) . . . . .	clockwise
Number of pinion teeth	
(one tooth blank) . . . . .	12
Mounting data:	
Number of mounting holes . . . . .	3
Diameter of mounting holes . . . . .	0.656 in.
Mounting holes circle diameter . . . . .	5.75 in.
Length . . . . .	18.72 in.
Height . . . . .	9.34 in.
Diameter (field ring) . . . . .	5.12 in.
Weight . . . . .	.63 lbs

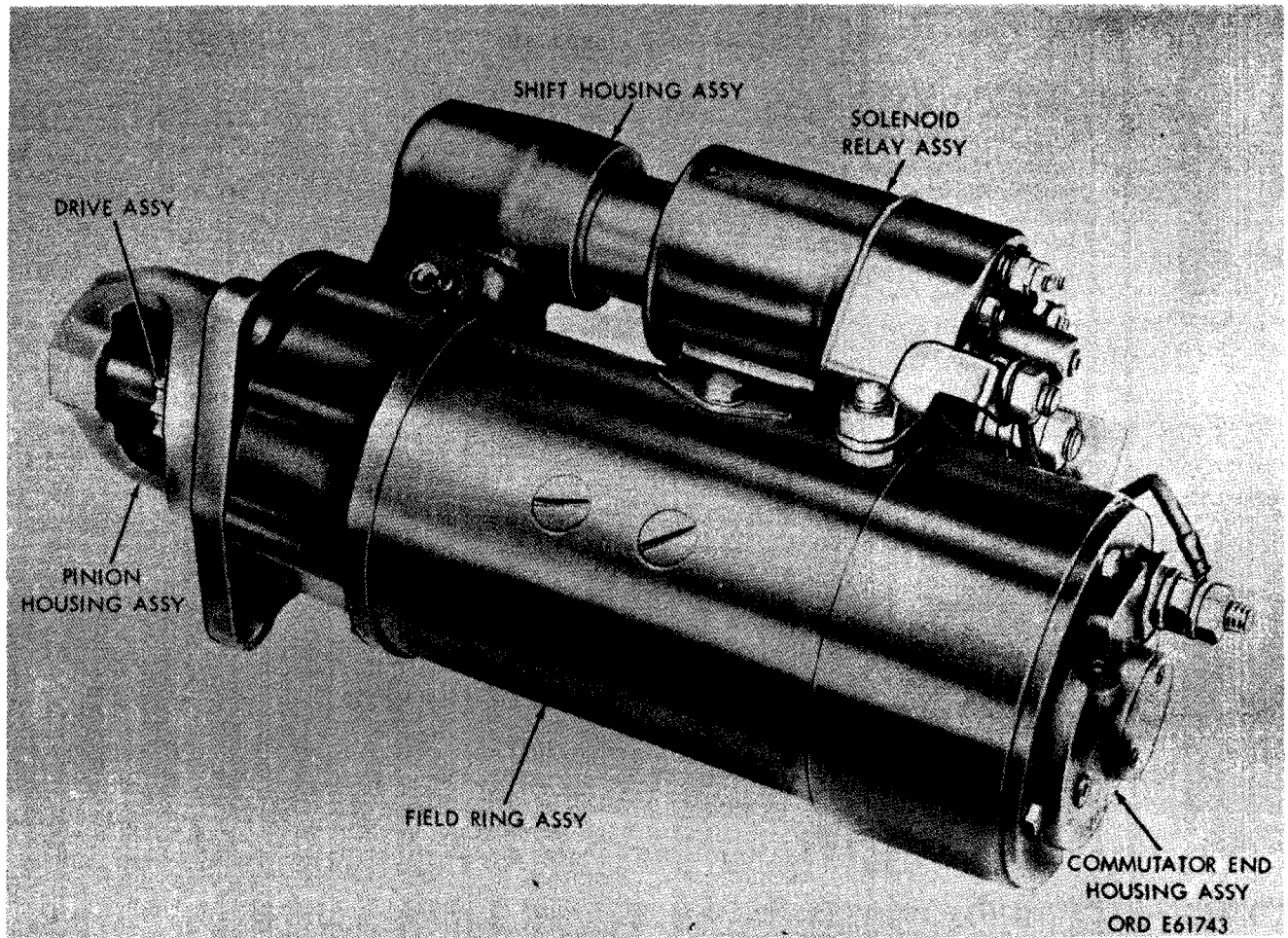
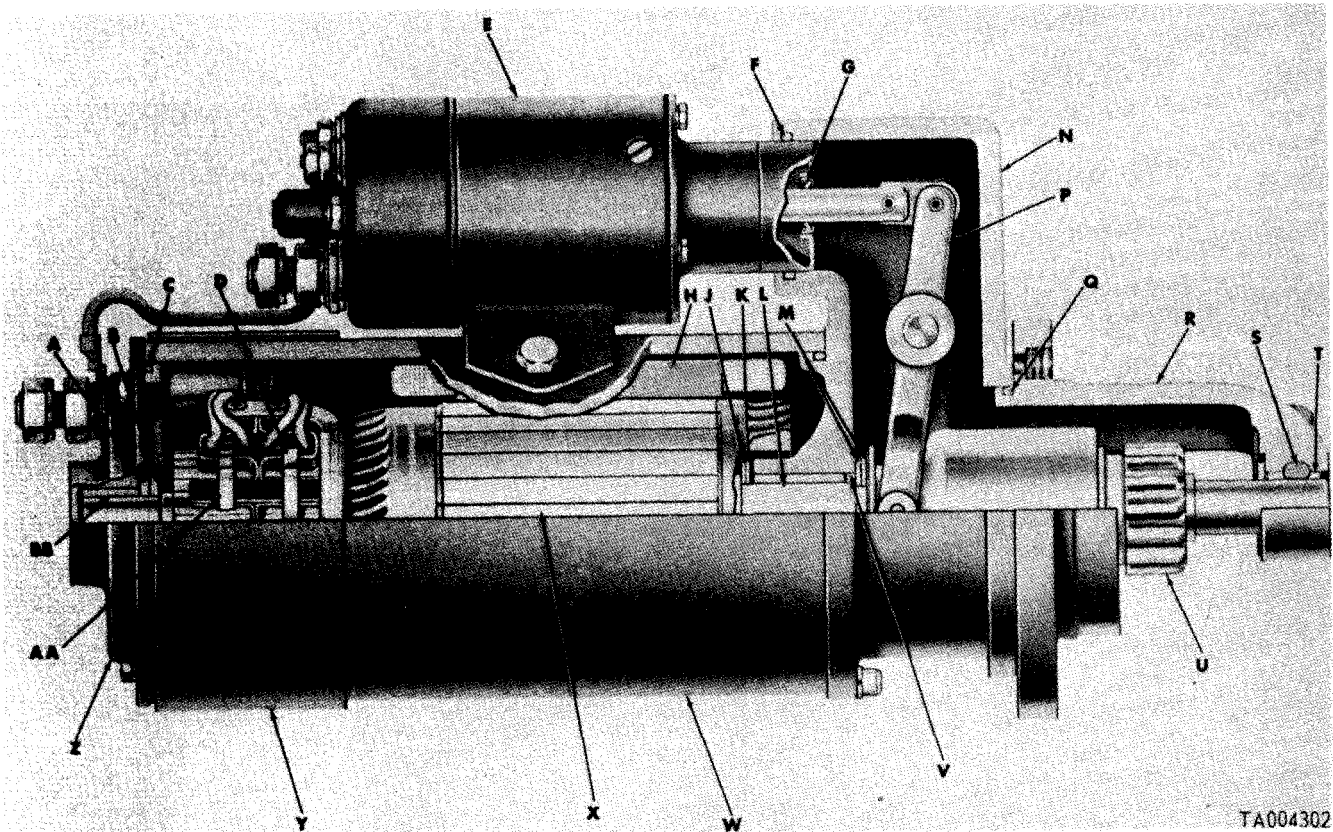


Figure 1-1. Electrical engine starter assembly.





TA004302

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|--|--|
| A - Fiber thrust washer                | P - Shaft and lever assembly                     |
| B - Steel thrust washer                | Q - Preformed packing                            |
| C - Preformed packing                  | R - Pinion housing                               |
| D - Brush                              | S - Oil wick                                     |
| E - Solenoid relay assembly            | T - Pinion housing bushing-type bearing          |
| F - Preformed packing                  | U - Drive assembly                               |
| G - Switch shaft seal                  | V - Armature oil seal                            |
| H - Field coils                        | W - Field ring                                   |
| J - Steel thrust washer                | X - Armature                                     |
| K - Fiber thrust washer                | Y - Brush opening band                           |
| L - Shift housing bushing-type bearing | Z - Commutator end housing                       |
| M - Fiber washer                       | AA - Brush holder and spring assembly            |
| N - Shift housing                      | BB - Commutator end housing bushing-type bearing |

Figure 1-2. Engine electrical starter assembly - sectional view.



## CHAPTER 2

### DIRECT SUPPORT AND GENERAL SUPPORT

### MAINTENANCE INSTRUCTIONS

#### Section I. REPAIR PARTS, SPECIAL TOOLS AND EQUIPMENT

##### 2-1. Tools and Equipment

Standard and commonly used tools and equipment having general application to this materiel are authorized for issue by Tables of Allowance (TA) and Tables of Organization and Equipment (TOE).

##### 2-2. Special Tools and Equipment

Special tools and equipment required to perform repair and rebuild operations contained in this manual are listed in appendix B.

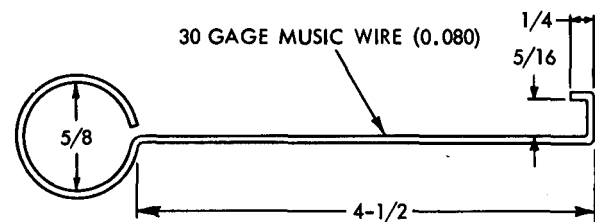
##### 2-3. Repair Parts

Repair parts for the starter assembly are listed in appendix B which is the authority for requisitioning replacements.

##### 2-4. Improvised Tools

The dimensional detail drawing of the improvised brush spring lifter (fig. 2-1) applies only to direct and general support shops to enable these maintenance organizations to fabricate the tools

locally, if desired. This tool is of chief value to maintenance organizations engaged in rebuilding a large number of identical components; however, it is not essential for rebuild and is not available for issue.



NOTE. ALL DIMENSIONS SHOWN ARE IN INCHES

ORD E61745

Figure 2-1. Improvised brush spring lifter.

#### Section II. TROUBLESHOOTING

##### 2-5. General

a. This section contains troubleshooting information for locating and correcting most of the operating troubles which may develop in the starter. Each malfunction for an individual component is followed by a list of tests or inspections which will help you to determine probable causes and corrective actions to take. You should perform the tests/inspections and corrective actions in the order listed.

b. This manual cannot list all malfunctions that may occur, nor all tests or inspections and corrective actions. If a malfunction is not listed or is not corrected by listed corrective actions, notify your supervisor.

c. Troubleshooting a disabled starter after it has been removed from the vehicle and/or engine consists of subjecting it to tests on a suitable test stand. Information pertaining to this testing is contained in paragraphs 3-26 through 3-29.

##### 2-6. Procedures

After the starter has been received by the maintenance activity for preliminary inspection, or if performance of the starter has been unsatisfactory due to unknown causes, it must be inspected as described in this section. When the cause for failure has been found, the starter should be disassembled and repaired before proceeding with the tests. Additional operational tests performed on a damaged starter would only increase the damage. The following chart lists the common malfunctions that might be encountered, their probable causes, and the recommended corrective action.

##### NOTE

Make certain that unusual noises are not produced by the test equipment used.

Table 2-1. Troubleshooting

Malfunction

Test or Inspection

Corrective Action

STARTER

1. Starter Fails to Crank.

Step 1. Check to see if starter is frozen.

Disassemble starter (para 3-4 through 3-12) and check for cause (para 3-14).

Step 2. Check to see if current is reaching starter by connecting a voltmeter between starter terminal and ground. Energise starter and observe voltmeter. A reading of approximately 24 volts should be indicated.

If no reading is noted, trace out starter circuit and check battery condition. (Refer to pertinent operator/organizational manual).

Step 3. Check to see if solenoid relay is defective by placing a jumper across battery terminal and relay terminal.

If relay does not operate, remove relay (para 3-5) and install new relay (para 3-25).

Step 4. Remove brush opening band (para 3-11a ), and check for poor brush spring tension and worn brushes (para 3-14e ).

This condition is usually indicated by a slight voltage drop at starter terminal.

If brushes are worn or spring tension is poor, replace brushes and/or springs as necessary and install band (para 3-20).

Step 5. Check for worn or pitted commutator. This condition may show a slight voltage drop when the starter is energized depending upon the extent of the damage.

Disassemble starter (para 3-4 through 3-12), resurface commutator (para 3-15e ), and assemble starter (para 3-16 through 3-25).

2. Low Speed and Low Current.

Step 1. Check for high internal resistance.

Remove brush opening band (para 3-11a ) and tighten brush leads. Install band (para 3-20f ).

Step 2. Check for poor brush contact by removing brush opening band (para 3-11a ) and inspecting commutator (para 3-14g ) for worn or dirty condition.

If commutator is worn or dirty, disassemble starter (para 3-4 through 3-12), resurface commutator (para 3-15e ), and assemble starter (para 3-16 through 3-25). Check for worn brushes (para 3-14e ).

3. Low Speed and High Current.

Step 1. Check to see if the armature is faulty due to excessive brush arcing.

If brush arcing is apparent, disassemble starter (para 3-4 through 3-12), check armature for grounds or shorts (para 3-14g ). Replace starter if armature is grounded.

Step 2. Check for armature drag by disassembling starter (para 3-3 through 3-12), inspect bearings and armature (para 3-14b c, g and h).

Repair armature (para 3-15e ), and/or replace bearings as necessary, and assemble starter (para 3-16 through 3-25).

4. Starter Produces Excessive Noise.

Step 1. Inspect bearings for lack of lubrication.

Lubricate bearings (para 3-17).

Step 2. Check for worn bearings by disassembling starter (para 3-4 through 3-12), and inspecting the bearings (para 3-14b, c, and h ).

Replace bearings, if necessary, and assemble starter (para 3-16 through 3-25).

Step 3. Inspect for loose pole shoes.

Tighten pole shoe screws.

5. Starter Fails to Crank or Operates Very Slowly.

Step 1. Check to see if armature shows excessive brush arcing, disassemble starter (para 3-4 through 3-12), check armature for grounds or shorts (para 3-14g ).

Replace starter if armature is grounded.

Step 2. Check for worn, binding, or poorly seated brushes by removing brush opening band (para 3-11a ), and checking brush spring tension (para 3-14e ) and brush condition.

Replace springs and/or brushes as necessary and install band (para 3-20f ).

Step 3. Check for poor commutation due to dirty, rough, or pitted commutator.

Disassemble starter (para 3-4 through 3-12), resurface commutator (para 3-15e ), and assemble starter (para 3-16 through 3-25).

Step 4. Check for eccentric commutator (out of round) by disassembling starter (para 3-4 through 3-12) and checking eccentricity (para 3-14g ).

Step 5. Inspect field coils to see if they are grounded (para 3-14f ).

If field coils are grounded, replace starter.

6. Excessive Arcing of Brushes.

Step 1. Remove brush opening band (para 3-11a ) and check for worn, binding or broken brushes or defective springs (para 3-14e ).

Replace brushes and/or springs as necessary and install band (para 3-20f ).

Step 2. Check for scored, pitted or dirty commutator.

Disassemble starter (para 3-4 through 3-12), resurface commutator (para 3-15e ), and assemble starter (para 3-16 through 3-25).

Table 2-1. Troubleshooting-Continued

## Malfunction

Test or Inspection

Corrective Action

## STARTER-Continued

- Step 3. Check for eccentric commutator (out of round) by disassembling starter (para 3-4 through 3-12) and checking eccentricity (para 3-14g).  
Repair commutator (para 3-15e), if possible, and assemble starter (para 3-16 through 3-25).
- Step 4. Inspect field coils for shorts or grounds (para 3-14f).  
If field coils are grounded, replace starter.
- Step 5. If armature shows excessive brush arcing, disassemble starter (para 3-4 through 3-12) check armature for grounds or shorts (para 3-14g).  
Replace starter if armature is grounded.
7. Starter Drive Fails to Engage.
- Step 1. Check operation of solenoid relay by placing a jumper across battery terminal and solenoid relay terminal. This should cause the relay to operate.  
If the relay does not operate, remove relay (para 3-5) and install new relay (para 3-25).
- Step 2. Check to see if solenoid relay linkage is adjusted properly (para 3-25f).  
If adjustment is incorrect, remove solenoid relay adjusting plug and adjust linkage (para 3-25f).
- Step 3. Check for binding in shift lever or drive assembly by partially disassembling starter (para 3-5, 3-6 and 3-7). Inspect lever (para 3-14i) and drive assembly (para 3-14d) for defective parts.  
Replace defective parts and assemble starter (para 3-23, 3-24 and 3-25).
8. Starter Vibrates During Operation.  
Check for worn or damaged bearings by disassembling starter (para 3-4 through 3-12), inspect bearings (para 3-14b, c, and h).  
Replace bearings if necessary and assemble starter (para 3-16 through 3-25).
9. Drive Assembly Pinion Will Not Override.  
Check for defective drive by disassembling starter (para 3-4 through 3-12) and inspecting drive assembly.  
Replace drive assembly, if necessary, and assemble starter (para 3-16 through 3-25).



## CHAPTER 3

### REPAIR INSTRUCTIONS

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#### Section I. GENERAL

##### 3-1. Removal and Installation

For instructions covering removal and installation of the starter, refer to TM 9-2320-211-20 for LDS-465-1, and LDS-465-1A and MACK Model ENDT 673 engines, TM 9-2320-209-20 for LD-465-1, LD-465-1C and LDT-465-1C engines, and TM 9-2320-230-20 for the LDS-465-2 engine.

##### 3-2. Cleaning Before Disassembly

Before beginning disassembly, wash starter exterior thoroughly with drycleaning solvent Type II (SD-2), Federal Specification P-D-680 and dry with compressed air (15 psi).

##### 3-3. Parts Kit

Standard parts kits should always be used when repairing or rebuilding starter assembly. Refer to Appendix B for description of parts kits.

#### Section II. DISASSEMBLY

##### 3-4. General

*a.* Disassembly of starter will be performed as illustrated in the following figures and instructions. Sequence of disassembly steps are shown in alphabetical order on each illustration.

*b.* All packings and gaskets will be discarded during disassembly and new parts installed during assembly.

##### 3-5. Removal of Solenoid Relay

*a.* Remove in following sequence: two hex nuts (A, fig. 3-1) and jumper (B); two hex nuts (C) and lockwashers (D); hex nut (E); and lead assembly (F).

*b.* Remove adjusting shaft access plug (fig. 3-2).

*c.* Remove two hex-head bolts (A, fig. 3-3) securing relay assembly (B) to field ring assembly.

*d.* Insert shaft adjusting tool (A, fig. 3-4) through access opening in relay cover. Engage end of tool with adjusting shaft and turn tool counterclockwise (B) until relay is free of plunger. Remove relay assembly (C).

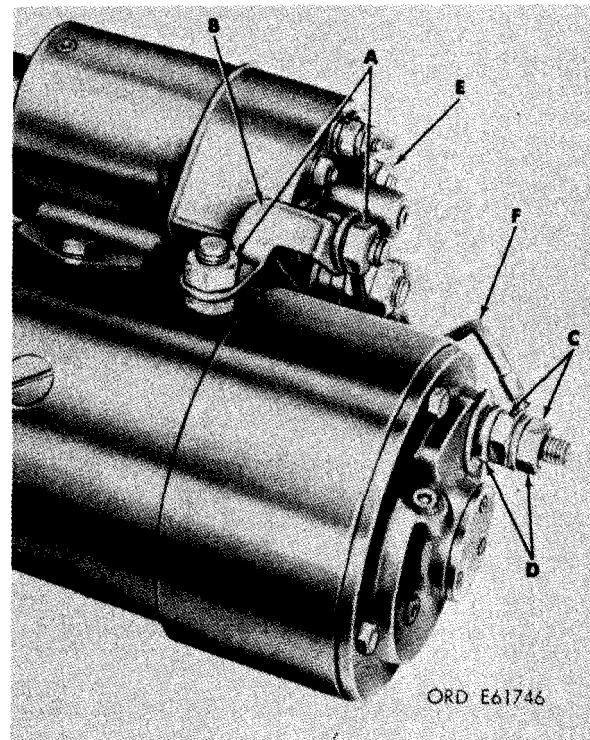


Figure 3-1. Removing or installing jumper and lead assembly.

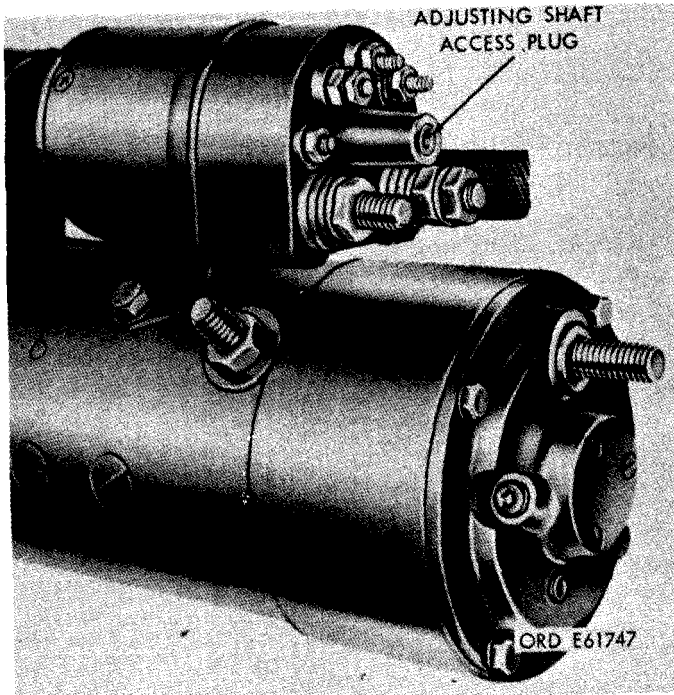


Figure 3-2. Removing or installing relay adjusting shaft access plug.

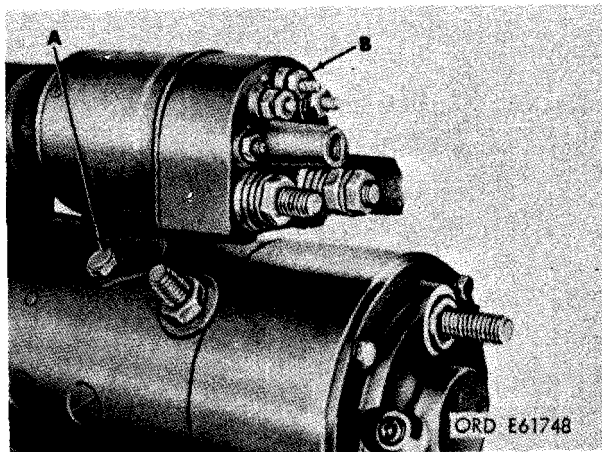


Figure 3-3. Removing or installing relay assembly attaching parts.

### 3-6. Removal and Disassembly of Pinion Housing Assembly

#### a. Removal.

(1) Scribe alinement marks (A, fig. 3-5) on shift housing and pinion housing (C) for proper positioning of pinion housing during assembly. Remove six hex-socket head screws (B). Tap around edges of pinion housing (C) to loosen housing pilot from its bore in shaft housing.

(2) Remove pinion housing (A, fig. 3-6), from starter and then remove and discard packing (B). Remove thrust washer (C) from armature shaft.

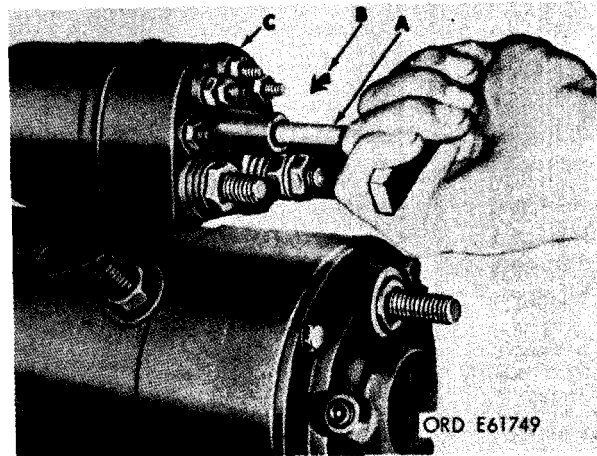


Figure 3-4. Disconnecting or connecting relay adjusting shaft using shaft adjusting tool.

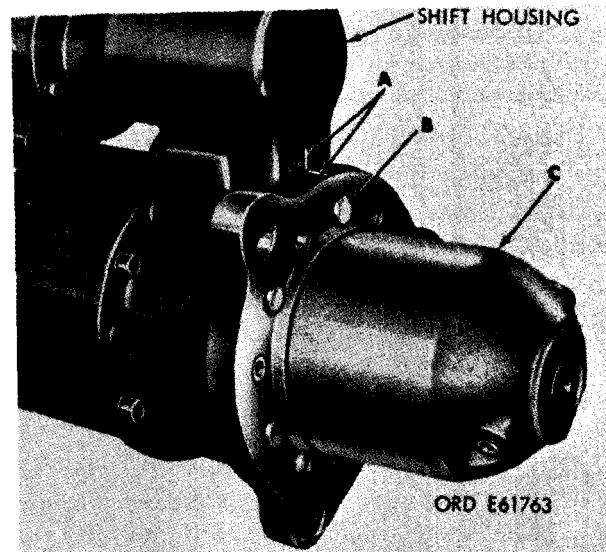


Figure 3-5. Removing or installing pinion housing assembly attaching parts.



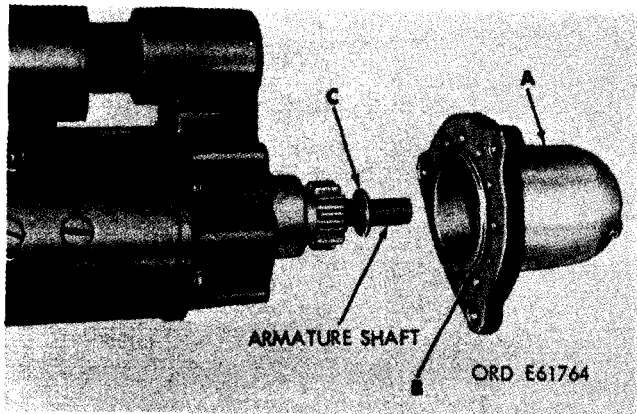


Figure 3-6. Removing or installing pinion housing and related parts.

b. *Disassembly.* Remove hex-socket head plug (A, fig. 3-7) and oil wick (B) from pinion housing. Remove six seal plugs (C) from housing. Do not attempt to remove bushing-type bearing since it should not be replaced unless it fails to meet inspection requirements (para 3-14b).

**3-7. Removal of Shift Housing Assembly**

a. Remove hex-socket head screw (A, fig. 3-8) and flat washer (B).

b. Thread hex-socket head screw (A, fig. 3-9) into lever shaft (B) and pull shaft from shift housing. Remove screw and packing (C) from shaft.

c. Scribe an alinement (A, fig. 3-10) on shaft housing assembly (D) and field ring. Remove six hex-socket head screws (B) and lockwashers (C). Slide shift housing assembly (D) forward to position shown in figure 3-11.

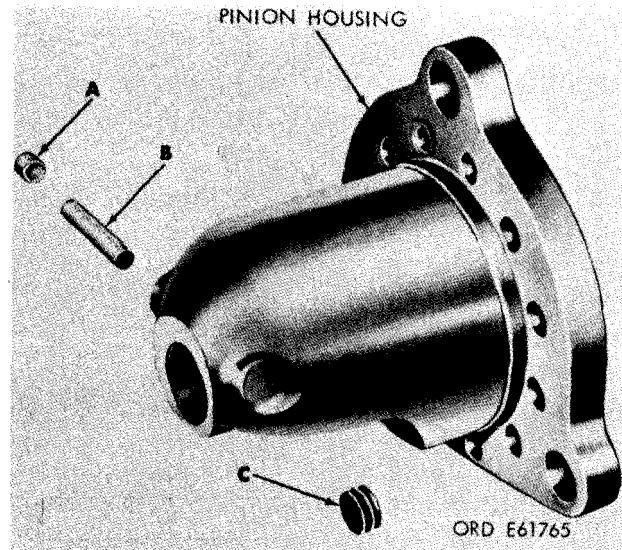


Figure 3-7. Removing or installing pinion housing oil wick.

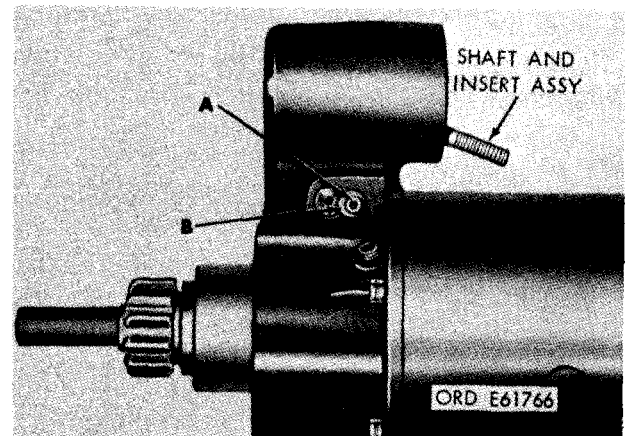


Figure 3-8. Removing or installing lever shaft retaining screw and washer.

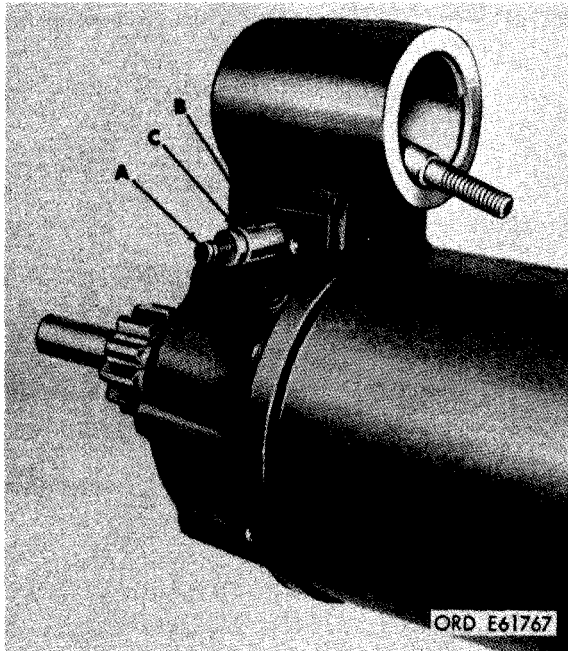


Figure 3-9. Removing or installing lever shaft.

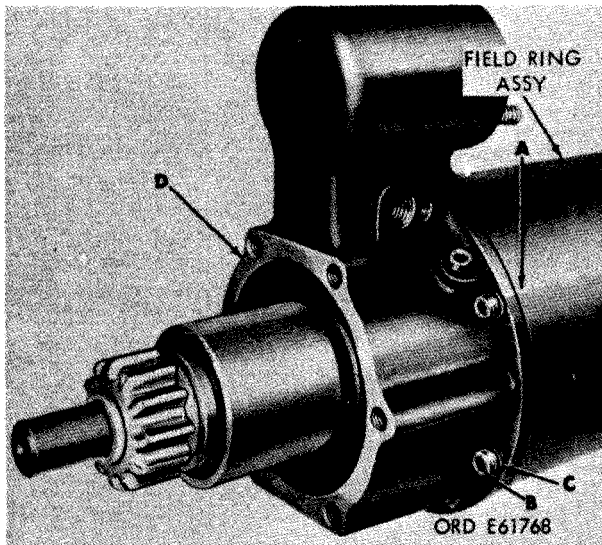


Figure 3-10. Removing or installing shaft housing assembly attaching parts.

d. Slide drive assembly (A, fig. 3-11) out of shift housing assembly and guide shaft and lever assembly (B) down and out of housing at the same time.

e. Remove two fiber thrust washers (A, fig. 3-12), shift housing assembly (B), fiber washer (C), and steel thrust washer (D) from armature shaft.

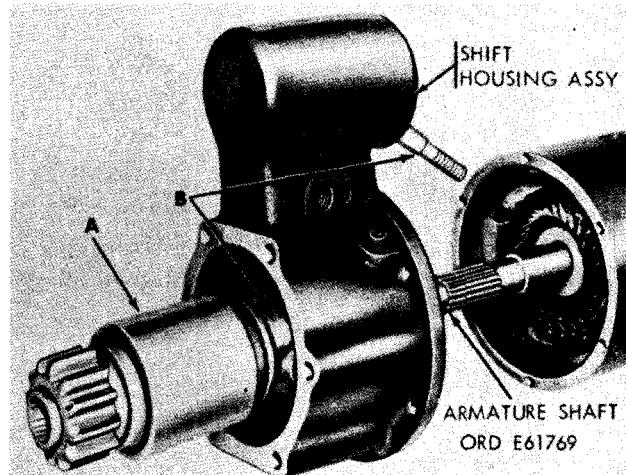


Figure 3-11. Removing or installing drive and lever assemblies.

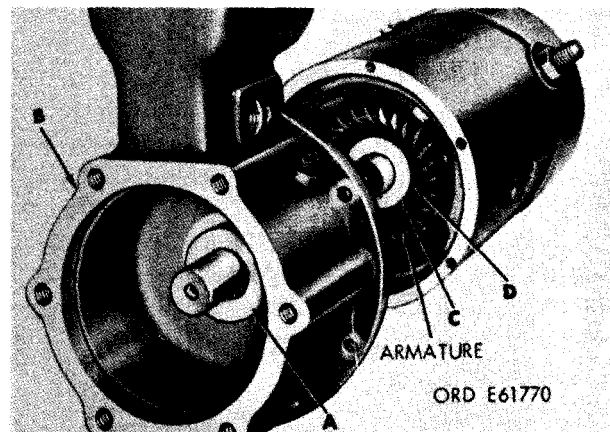


Figure 3-12. Removing or installing drive clutch thrust washers.

### 3-8. Shaft and Lever Assembly (Fig. 3-13)

Press out roll pins (A and C) to separate shaft and insert assembly (B) and coupling (D) from lever arm assembly.

#### NOTE

Shaft and lever assembly should not be disassembled unless inspection (para 3-14) indicates need for replacing one of components.

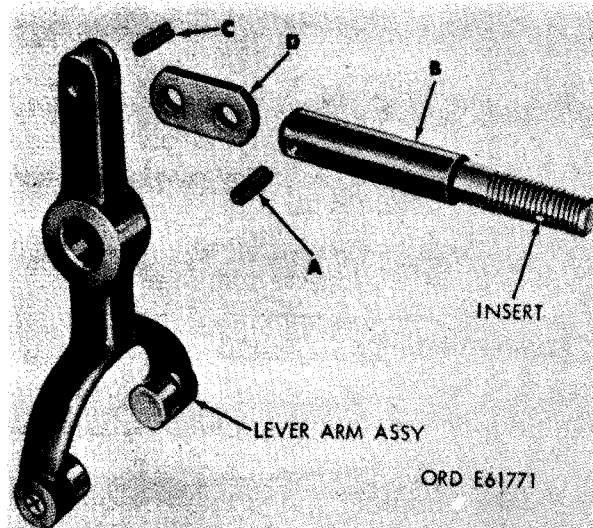


Figure 3-13. Disassembling or assembling shaft and lever assembly.

### 3-9. Shift Housing Assembly (Fig. 3-14)

Remove and discard packing (A and B). Remove hex-socket head plug (C) and oil wick (D).

**NOTE**

Do not attempt to remove bushing-type bearing unless inspection (para 3-14c) indicates for replacement.

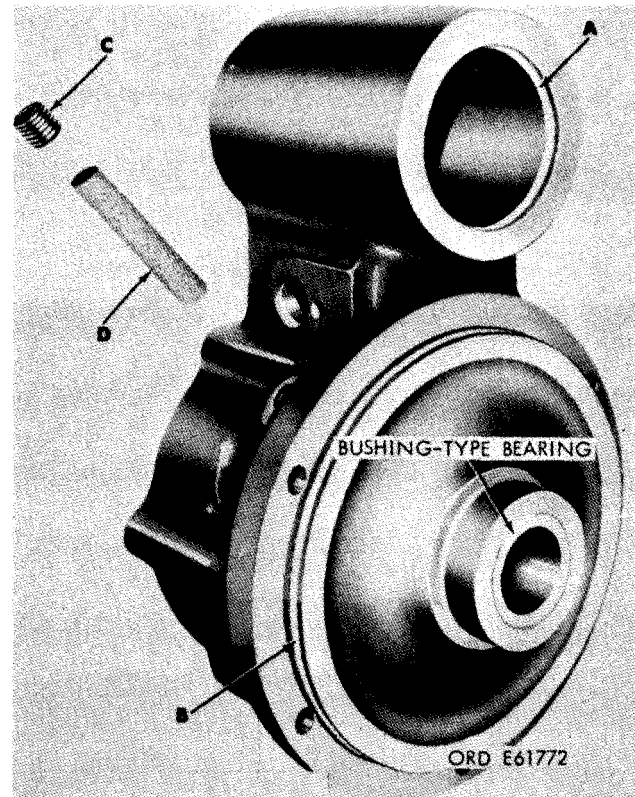


Figure 3-14. Removing or installing shift housing packings and oil wick.

### 3-10. Removal of Armature Assembly

Remove armature assembly from field ring assembly as shown in figure 3-15. Remove fiber thrust washer (A, fig. 3-16) and steel thrust washer (B) from armature.

**NOTE**

The fit of thrust washer (B, fig. 3-16) can vary from a slip to a press fit. It may be necessary to press washer off armature shaft.

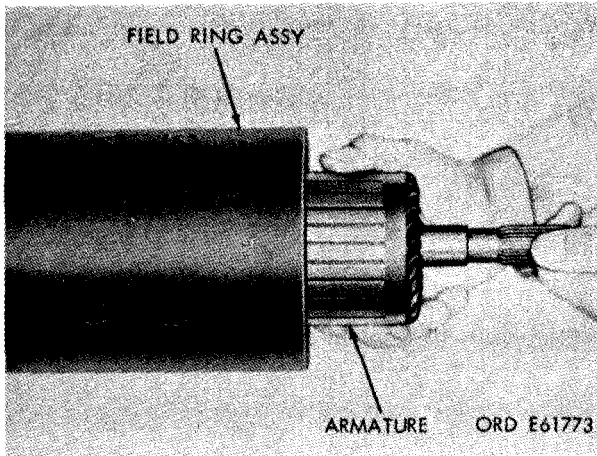


Figure 3-15. Removing or installing armature.

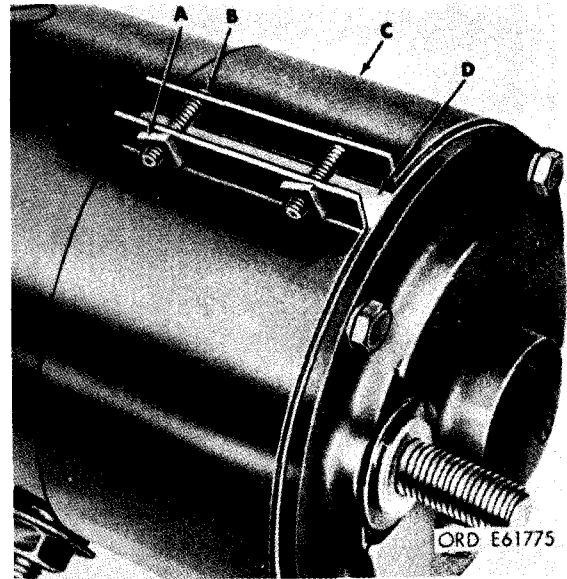


Figure 3-17. Removing or installing brush opening band.

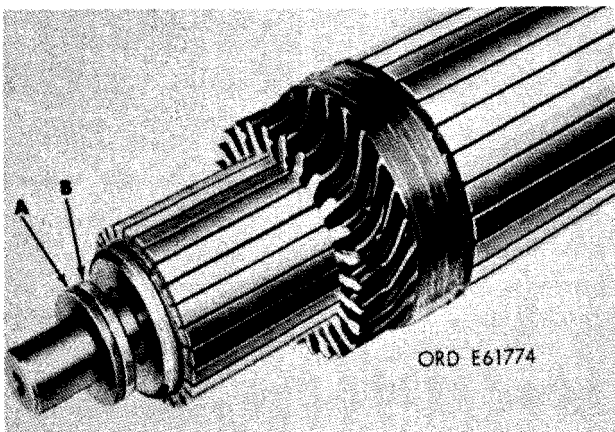


Figure 3-16. Removing or installing armature thrust washers.

### 3-11. Removal of Brush Rigging Assembly

a. Remove two square nuts (A, fig. 3-17), two round-head screws (B), brush opening band (C), and band (D).

b. Remove two cross-recessed head screws (A, fig. 3-18) and one lock plate (B) from each of four brush attaching locations.

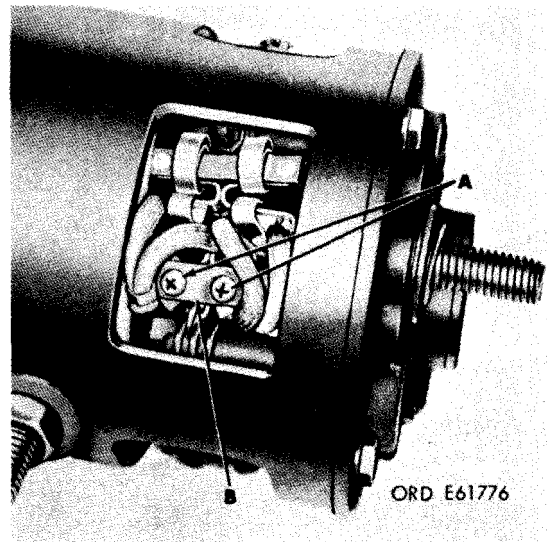


Figure 3-18. Disconnecting or connecting brushes.

c. Using an improvised brush spring lifter (A, fig. 3-19) pull the brush spring (B) out of the way and slide brush (C) out of its holder. Remove remaining seven brushes in same manner. (See paragraph 2-4 for instructions to make, and authorization for use of, the improvised brush spring lifter).

d. Scribe an alignment mark (A, fig. 3-20) on end housing and field ring. Remove four hex-head screws (B) and lock washers (C). Pull brush rigging assembly (D) out of field ring assembly.

**NOTE**

It may be necessary to tap around edge of housing with a soft hammer to loosen packing seal effect.

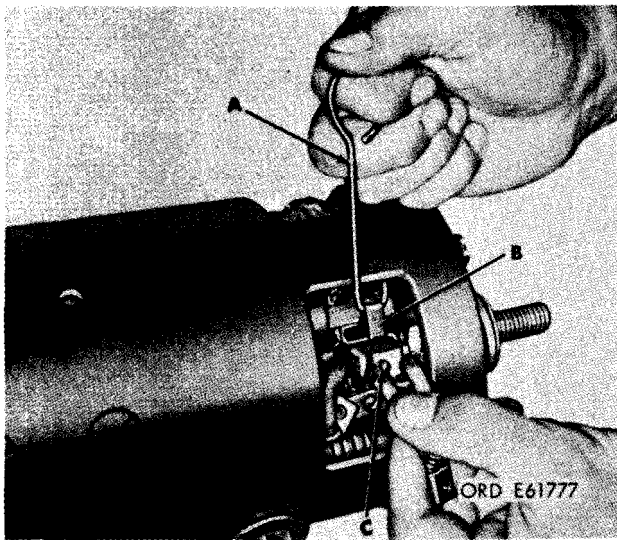


Figure 3-19. Removing or installing brushes in brush rigging using improvised brush spring lifter.

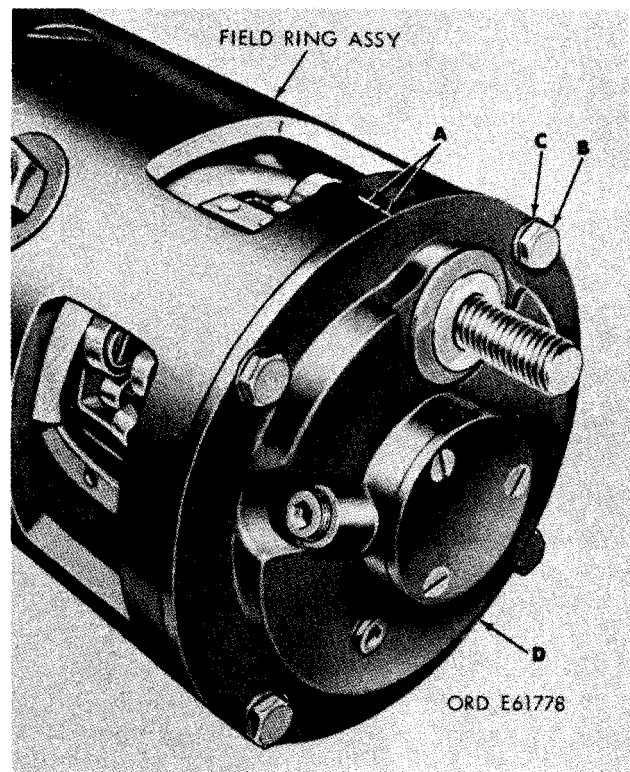


Figure 3-20. Removing or installing brush rigging assembly attaching parts.

### 3-12. Brush Rigging Assembly

a. Remove brush holder jumper (A, fig. 3-21) and packing (B). Discard packing.

**NOTE**

Brush holder jumper (A) may fall loose in field ring assembly when removing brush rigging assembly.



b. Remove one cross-recessed head screw (A, fig. 3-22), one double-coil lockwasher (B), and one insulating washer (C), at each of four brush holder supports. Remove and separate the four brush holder and spring assemblies (D), twelve insulating washers (E), and insulating bushing (F).

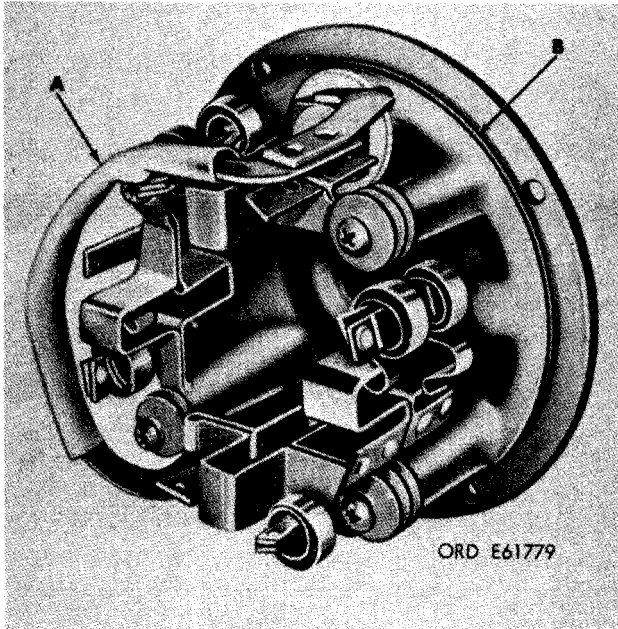


Figure 3-21. Removing or installing brush rigging.

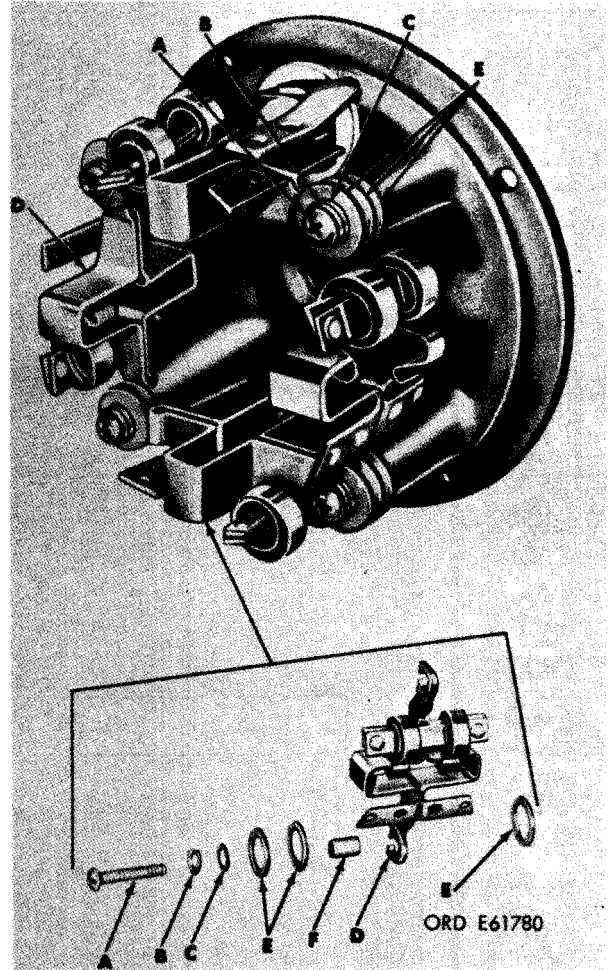


Figure 3-22. Removing or installing brush spring holders.

c. Remove two guard washers (A, fig. 3-23) and insulating bushing (B) from jumper screw (C). Slide jumper screw out of commutator end housing and then remove insulating bushing (D) and sealing ring (E).

d. Remove three flat head screws (A, fig. 3-24) cover plate (B), and plate gasket (C). Discard gasket. Remove two hex-socket head plugs (D) and oil wick (E).

#### NOTE

Do not attempt to remove bushing-type bearing unless inspection (para 3-14 h) indicates need for replacement.

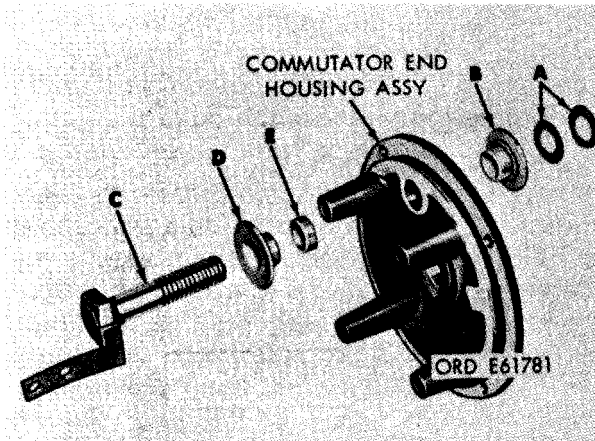


Figure 3-23. Removing or installing brush rigging jumper screw and attaching parts.

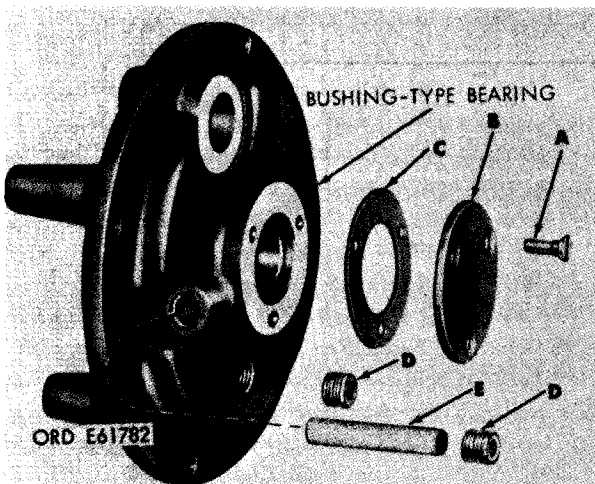


Figure 3-24. Disassembling or assembly commutator end housing assembly.

### 3-13. Cleaning

#### WARNING

Particles blown by compressed air are hazardous. Make certain air stream is directed away from user and any other persons in area.

a. *General.* Wash all parts, except those detailed in 3-13 b through 3-13f below, in dry-cleaning solvent, Type II (SD-2), Specification P-D-680, and dry with compressed air.

b. *Field Coils.* Clean field coils and field ring thoroughly with a cloth dampened with dry-cleaning solvent. Be careful not to damage protective insulation coating. Dry thoroughly with compressed air (15 psi max.).

c. *Armature.* Remove loose particles from armature and wipe with a clean cloth dampened with dry-cleaning solvent. Clean commutator lightly with 00 sandpaper and remove all dust with compressed air.

d. *Brushes.* Clean brushes with a clean, dry cloth only. Extreme care must be taken to prevent dry-cleaning solvent from contacting brushes.

e. *Relay Coil and Shell Assembly.* Only external metal surfaces of relay coil and shell assembly can be cleaned. Clean with a cloth dampened in dry-cleaning solvent.

f. *Non-Metallic Components.* Do not clean such parts as sealing rings, insulating bushings, and insulating washers. Wipe with a clean, dry cloth.

### 3-14. Inspection

a. *General.* Inspect all screws, bolts, nuts, threaded holes, and plugs for worn or damaged threads. Replace all worn or damaged parts. Inspect remaining hardware items and replace damaged parts.

b. *Pinion Housing.*

(1) Inspect pinion housing for cracks, distortion, and burs. Replace if damaged.

(2) Inspect housing bushing-type bearing for score marks and wear patterns. Check bearing against limits specified in repair and rebuild standards (para 3-31 d) and replace (para 3-15 b), if worn beyond limits.

(3) If housing bushing-type bearing is removed (para 3-15 b), check diameter of bearing bore in pinion housing against limits specified in repair and rebuild standards (para 3-31d). Replace housing if worn beyond limits.

*c. Shift Housing Assembly.*

(1) Inspect shift housing for cracks or distortion and burrs on mating flange and packing surfaces. Replace if damaged.

(2) Inspect bushing-type bearing for score marks and wear patterns. Check bearing against limits specified in repair rebuild standards (para 3-31e) and replace (para 3-15c) if worn beyond limits.

(3) If the bushing-type bearing is removed from the shift housing, check diameter of bearing bore against limits specified in repair and rebuild standards (para 3-31e). Replace shift housing if worn beyond limits.

*d. Drive Assembly.*

(1) Inspect bearing surface and drive assembly internal splines for score marks and wear patterns. Replace drive if worn or damaged.

(2) Check drive spring against limits specified in repair and rebuild standards (para 3-31a) and replace spring if it is not within these limits.

(3) Inspect drive collar for signs of wear and distortion and replace drive assembly if either condition exists.

(4) Inspect gear teeth for wear pattern and replace drive assembly if wear is excessive.

*e. Brush Holder Assemblies and Brushes.*

(1) Inspect brush holder and spring assemblies for any visible damage. Replace if damaged. Check brush spring tension with a 0 to 40 ounce spring scale. It should require approximately 36 ounces to lift end of spring out of brush holder. If tension is less than 30 ounces, replace holder and spring assembly.

(2) Inspect brushes for chips, cracks, loose terminal leads, and grease spots. Check length of brushes against limits specified in repair and rebuild standards (para 3-31a.). Replace brushes if worn beyond these limits.

*f. Field Ring Assembly.*

(1) Check field coils for insulation breakdown with an ohmmeter. Attach one probe of ohmmeter to field coil terminal and the other probe to field ring (fig. 3-25). The minimum reading should not be less than one megohm. If field coils are damaged, replace starter.

(2) Inspect field frame for cracks and burrs. Replace starter if cracked.

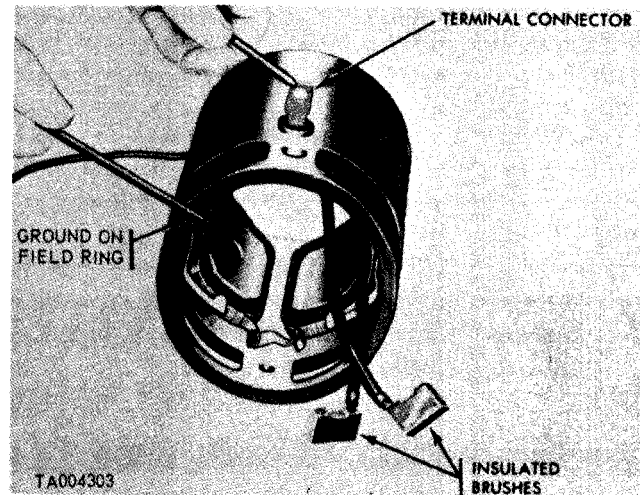


Figure 3-25. Testing field coils for grounds.

*g. Armature Assembly.*

(1) Inspect commutator contact surface of armature. A satisfactory condition is indicated by an even, highly burnished, dark-copper color. If contact surface is rough, pitted, scored, burned, or coated with hard carbon or oil, commutator must be cleaned or resurfaced as necessary, provided it is in good electrical and mechanical condition as a result of following inspection. Check armature against limits specified in repair and rebuild standards (para 3-31 a) and replace starter if it is not within these limits. Inspect splines of armature shaft for wear or damage and replace starter if either condition exists.

(2) Inspect armature for grounds with a test light by touching one probe to commutator bar riser and other to armature core (fig. 3-26). Test all commutator bars in this manner. If test light glows, armature is grounded and starter must be replaced.

(3) Inspect armature for short circuits with a growler. Place armature in growler and hold a thin strip of steel, such as a hacksaw blade, about 1/32 to 1/16-inch away from armature core as shown in figure 3-27. While holding steel strip in position, rotate armature slowly in growler. A short circuit will pull the steep strip tightly against armature core and cause strip to vibrate. If a short circuit is found, starter must be replaced.



(4) Inspect armature shaft alignment and commutator for eccentricity to shaft with a lathe or V-blocks and a dial indicator (fig. 3-28). Check armature shaft for true alignment. If shaft runout exceeds 0.005-inch, commutator of armature shaft must be resurfaced provided it will not be cut below limits specified in repair and rebuild standards (para 3-31 *a*). If commutator requires cutting below limits specified, replace starter.

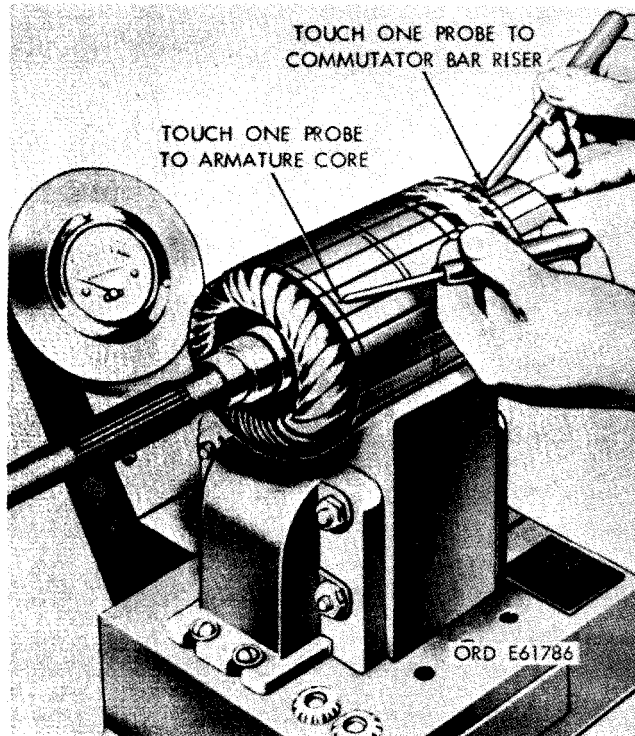


Figure 3-26. Testing armature for grounds.

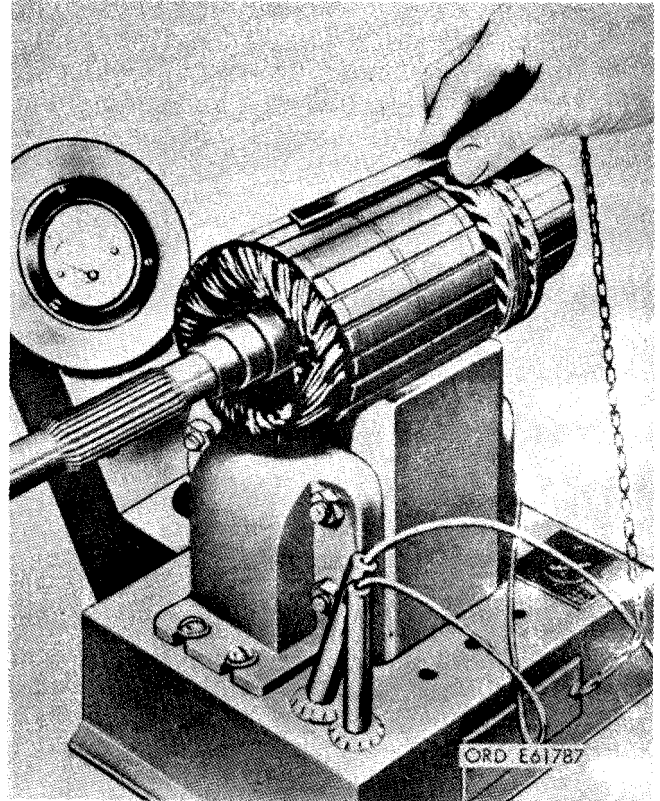


Figure 3-27. Testing armature for short circuits.

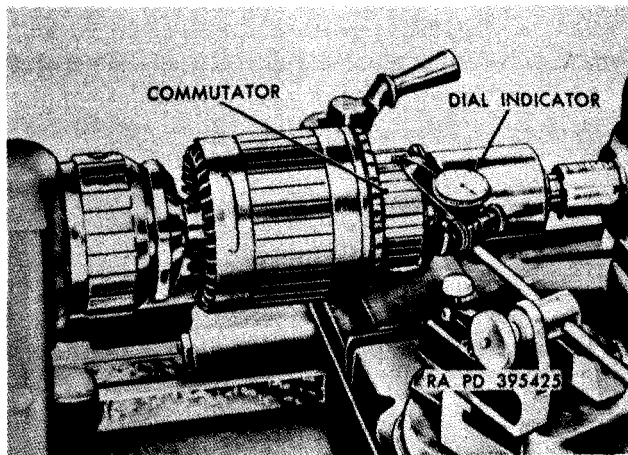


Figure 3-28. Checking armature eccentricity.

#### *h. Commutator End Housing Assembly.*

(1) Inspect commutator end head for cracks, distortion, and burrs. Replace if damaged.

(2) Inspect bushing-type bearing for score marks and wear patterns. Check bearing against limits specified in repair and rebuild standards (para 3-31c) and replace if worn beyond limits.

(3) If head bushing-type bearing is removed, check diameter of bearing bore in commutator end head against limits specified in repair and rebuild standards (para 3-31c). Replace head if it is not within these limits.

#### *i. Shaft and Lever Assembly.*

(1) Inspect shaft for wear on shaft or burrs in packing area. Replace shaft if worn or damaged. Examine nylon insert in threaded portion of shaft and replace if damaged or worn beyond usefulness. Check against limits specified in repair and rebuild standards (para 3-31b) and replace if parts are beyond these limits.

(2) Inspect lever for wear on slider blocks. Replace lever if wear exists.

### **3-15. Repair**

*a. General.* The following subparagraphs cover only those parts wherein a repair operation will return damaged part to serviceable condition. Parts not detailed herein must be replaced when they fail to pass the required inspection (para 3-14).

*b. Pinion Housing.* Smooth minor burrs or damage on mating surfaces of pinion housing with a fine mill file. If bushing-type bearing did

not meet allowable wear limits, remove it as shown in figure 3-29 and replace it with a new bearing. Press new bearing into position. Drill bushing oil hole using a  $21/64$ -inch diameter drill and oil wick bore as a pilot. Ream bearing to a diameter of  $0.750 \pm 0.001$ -inch.

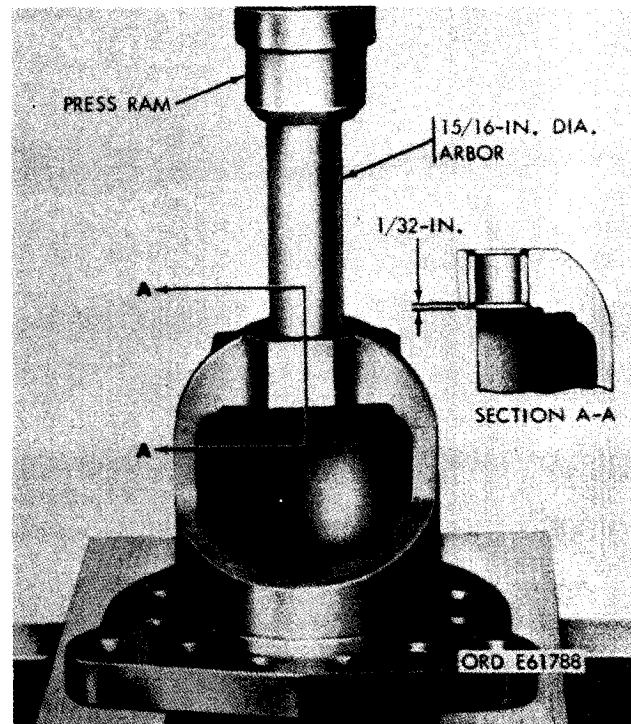


Figure 3-29. Removing or installing bearing in pinion housing.

#### *c. Shift Housing Assembly.*

(1) Smooth minor damage such as nicks, burrs, etc., on mating surfaces of housing with a fine mill file.

(2) If bushing-type bearing did not meet allowable wear limits, remove the old bearing as shown in figure 3-30. When installing a new bearing, reposition housing with opposite side up from that shown in figure 3-30 and press bearing in flush with housing bore. Drill bushing oil hole using a  $21/64$ -inch diameter drill and oil wick bore as a pilot. Ream bearing to a diameter of  $0.875 \pm 0.001$ -inch.

#### **NOTE**

Bearing can be pressed flush more easily if a 1-inch arbor is used. This will not allow bearing to be pressed below surface.

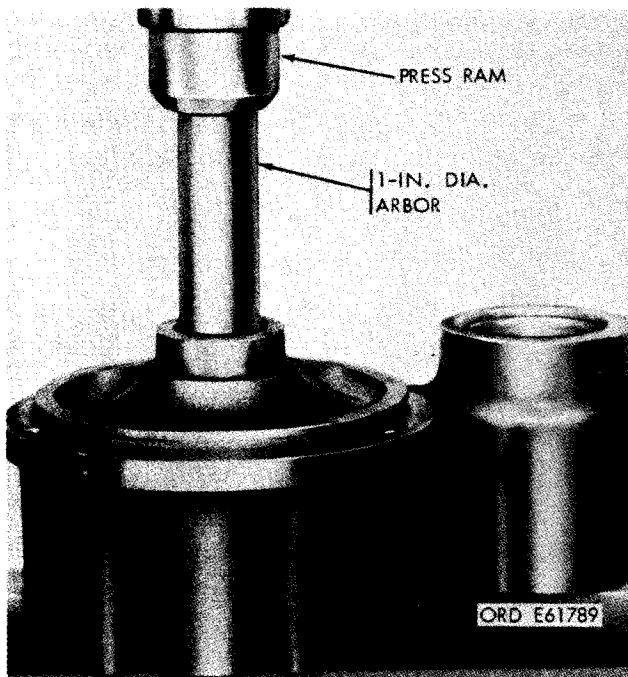


Figure 3-30. Removing or installing bearing in shift housing.

*d. Commutator End Housing Assembly.*

(1) Smooth minor damage such as nicks, burs, etc., on mating surface of housing with a fine mill file.

(2) If bushing-type bearing did not meet allowable wear limits, remove old bearing as shown in figure 3-31. Install a new bearing in the same manner. It should be pressed in so that it is flush with housing bore. Drill bushing oil hole using a  $21/64$ -inch diameter drill and oil wick bore as a pilot. Ream bearing to a diameter of  $0.730 \pm 0.001$ -inch.

**NOTE**

Bearing can be pressed flush more easily if a  $15/16$ -inch arbor is used. This will not allow bearing to be pressed below surface.

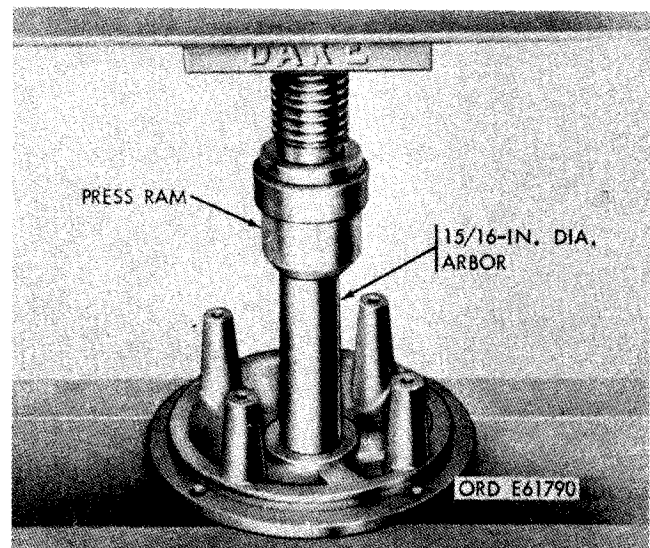


Figure 3-31. Removing or installing bearing in commutator end housing.

*e. Armature.*

(1) *Resurfacing.* Sharpen lathe cutting tool to dimensions given in figure 3-32. For commutator turning, lathe cutting tool must be extremely sharp. After grinding, hone tool with a fine hard stone to insure a smooth cut during turning operation.

Position tool with respect to commutator as shown in figure 3-33. Resurface commutator at 800 rpm taking only light cuts each time. No more than 0.005-inch should be removed during any one cut and the final cut should not be more than 0.002-inch. After resurfacing, check commutator against limits specified in repair and rebuild standards (para 3-31) and replace it if it falls below these limits.

**NOTE**

When a cut is started, it should be carried across entire surface without stopping.

**NOTE**  
The armature used in this starter is a flush mica design and the undercutting

operation normally performed after resurfacing is not required.

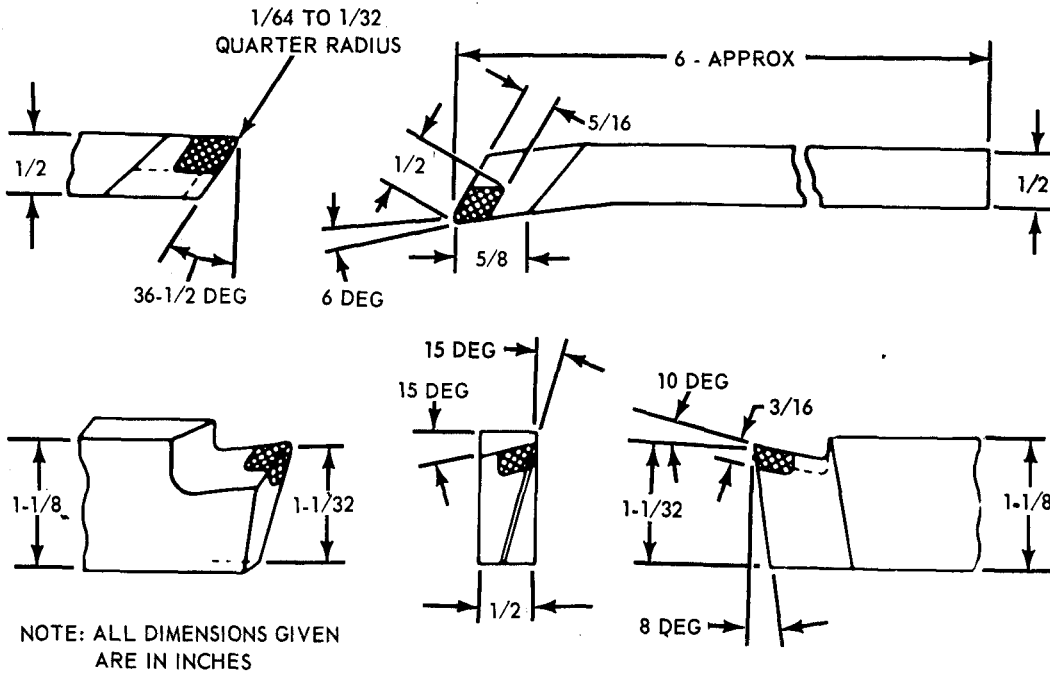
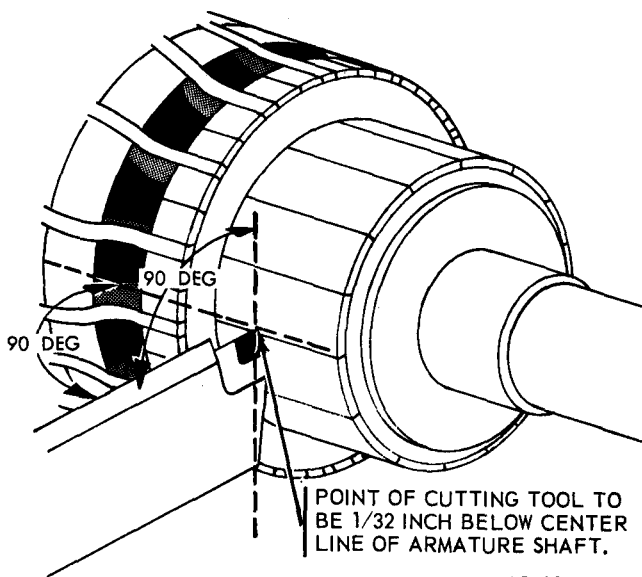


Figure 3-32. Cutting tool sharpening dimensions.

RA PD 395427



RA PD 395423

Figure 3-33. Proper position of cutting tool.

(2) *Polishing commutator.* Remove all copper and mica particles with compressed air. Polish commutator in a lathe with 2/0 sandpaper as illustrated in figure 3-34, with armature rotating at 1500 rpm.

(3) *Checking armature eccentricity.* Set up a dial indicator gage and measure the runout of the commutator (fig. 3-28). Total runout should not exceed 0.003-inch.

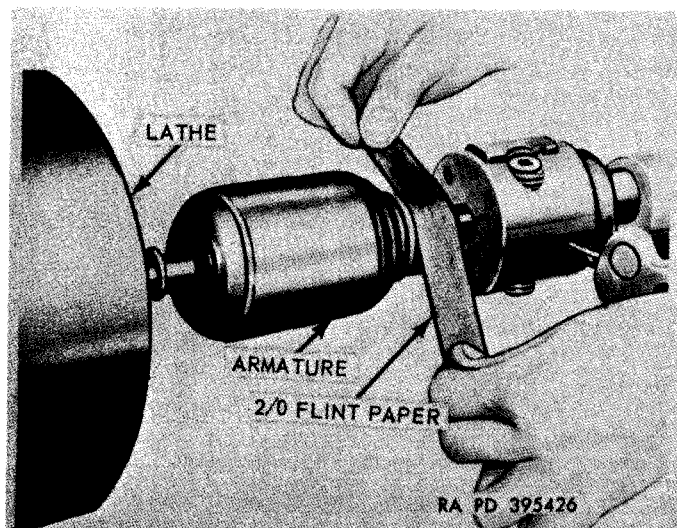


Figure 3-34. Polishing armature commutator with sandpaper.

Section III. ASSEMBLY

3-16. General

a. Instructions covering assembly of the starter are almost identically the reverse of those covering disassembly. Therefore, the following assembly procedures, for the most part, will be referenced to paragraphs appearing in section II. When this occurs, instructions appearing with each referenced paragraph should be performed in reverse order from which they are given.

For example, if reference is made to paragraph 3-12 then disassembly subparagraphs a through d and any instructions contained therein also should be performed in reverse order. Throughout assembly procedure, it will be assumed that the referenced disassembly instructions must be performed in reverse order to accomplish the assembly procedure.

b. Figure B-2 in appendix B of the manual provides a visual reference to relationship of components of starter and for parts identification.

c. Four parts kits are provided for use in repair and rebuild of the electrical engine starter assembly. When any component of a kit requires replacement, all parts in the kit should be replaced at the same time. Whenever the starter is rebuilt, complete contents of gasket and seal parts kit should be used.

**3-17. Lubrication**

The lubricants listed in table 3-1 should be available for use during assembly. Table 3-1 lists lubricant, part to which it is applied, and method of application. Make certain that these instructions are performed during assembly.

Table 3-1. Lubrication Instructions

Fig. No.	Index No.	Point of lubrication	Lubricant	Instructions
B2	6	Preformed packings	OIL, lubricating (OE-30), MIL-L-2104	Apply lightly
	14			
	18			
	58			
	10	Lever assy: In shaft bore on slider blocks	GREASE, aircraft and instrument, MIL-G-23827	Apply lightly on contact surfaces.
	12	Coupling: In pin holes	GREASE, aircraft and instrument, MIL-G-23827	Apply lightly on contact surfaces.
	28	Armature assy: On splines	OIL, lubricating, (OE/HDO-10) MIL-L-2104	Apply lightly on contact surfaces.
	8	Drive assy: In inner	OIL, lubricating (OE/HDO-10) MIL-L-2104	Apply lightly on contact surfaces.
	4	Oil wicks	OIL, lubricating (OE-30), MIL-L-2104	Soak until saturated.

**3-18. Brush Rigging Assembly**

a. Refer to paragraph 3-12 and reverse disassembly for assembly of brush rigging assembly. Do not install jumper (A, fig. 3-21) as shown.

**NOTE**

The brush holders (D, fig. 3-22) are designed to overlap each other at brush holders supports when in assembled position and must be installed properly.

b. Position jumper coil (A), as shown in figure 3-35, on brush rigging assembly and hold it in position using one screw (B).

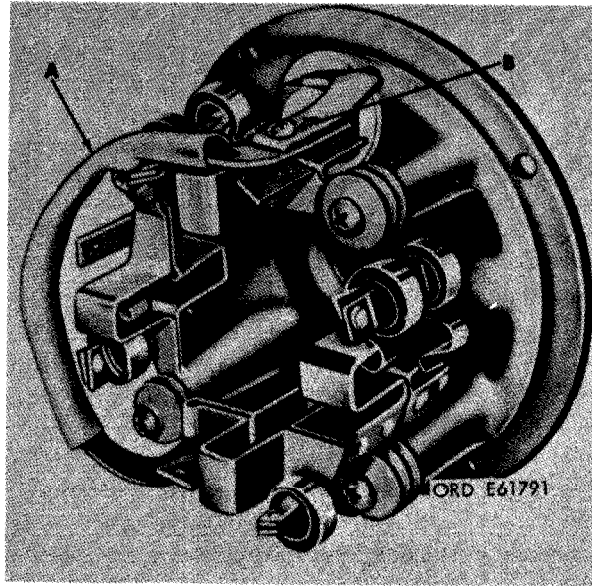


Figure 3-35. Position jumper on brush rigging assembly.

**3-19. Installation of Brush Rigging Assembly**

Refer to paragraph 3-11 and reverse removal instructions for installation of brush rigging assembly. Make certain scribe marks (A, fig. 3-20) are aligned.

**3-20. Installation of Armature Assembly and Brushes**

a. Position sandpaper on armature as shown in

figure 3-36 and secure one end with masking tape. Install armature as instructed in paragraph 3-10.

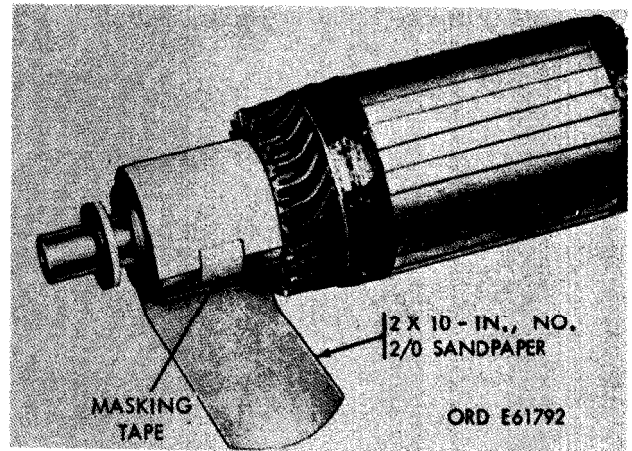


Figure 3-36. Positioning sandpaper on armature.

b. Refer to paragraph 3-11c and reverse removal instructions for installation of brushes in brush holders. Make certain brush springs hold brushes securely against armature.

c. Rotate armature clockwise as shown in figure 3-37 to seat brushes. Continue this procedure until a proper brush seat has been obtained as shown in figure 3-38.

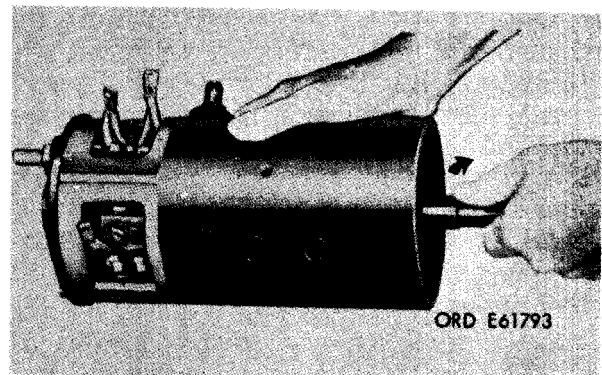


Figure 3-37. Rotating armature to seat brushes.

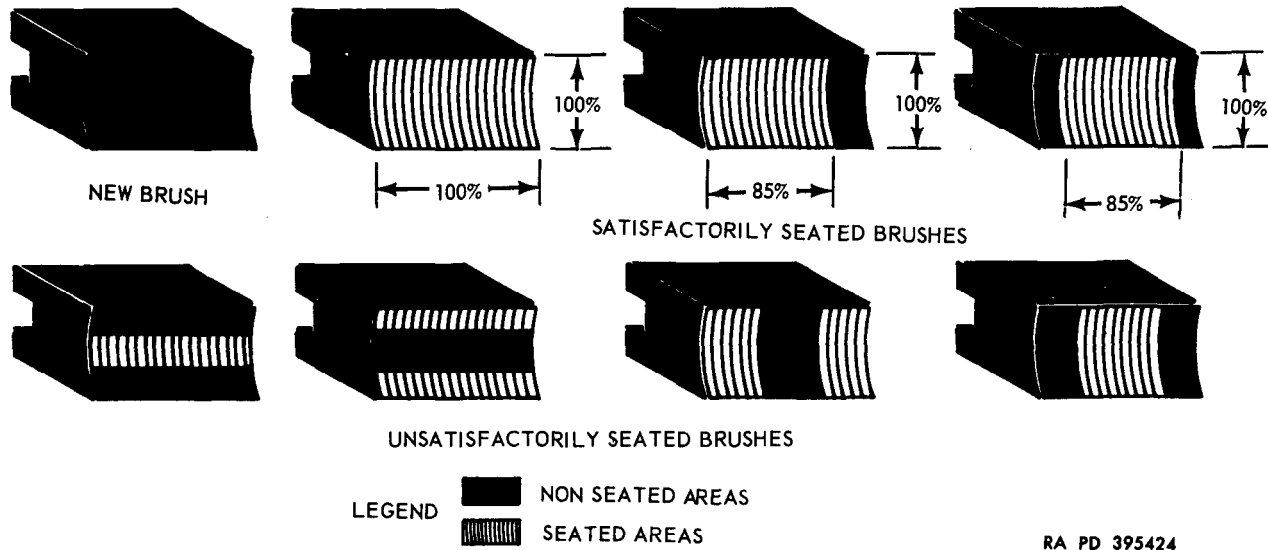


Figure 3-38. Examples of satisfactory and unsatisfactory brush seats.

d. Remove brushes following instructions provided in paragraph 3-11c. Remove armature and discard sandpaper. Clean armature and brushes (para 3-13c and d).

e. Refer to paragraph 3-10 and reverse removal instructions for installation of armature and thrust washers.

f. Refer to paragraph 3-11a through c and reverse removal instructions for installation of brushes and brush opening band.

**NOTE**

Remove screw (B, fig. 3-35) before securing brushes.

**3-21. Shift Housing Assembly**

Refer to paragraph 3-9 and reverse disassembly instructions for assembly of shift housing assembly.

**3-22. Shaft and Lever Assembly**

Refer to paragraph 3-8 and reverse disassembly instructions for assembly of shaft and lever assembly.

**3-23. Installation of Shift Housing Assembly**

a. Refer to paragraph 3-7 and reverse removal instructions for installation of shift housing assembly. Make certain scribe marks (A, fig. 3-10) on field ring and shift housing assembly are aligned.

b. Check armature end play as shown in figure 3-39. End play must be 0.015 to 0.070 inch. If end play is excessive, disassemble starter (para 3-7 and 3-10), replace thrust washer, and assemble, (para 3-20).

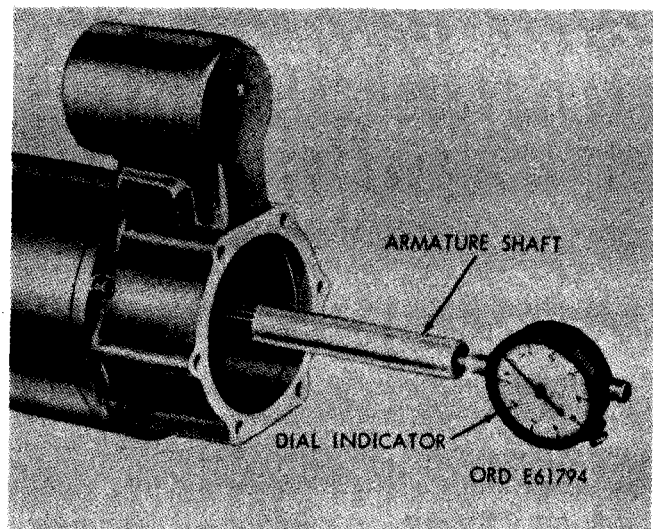


Figure 3-39. Measuring armature end play.

**3-24. Assembly and Installation of Pinion Housing Assembly**

a. *Assembly.* Refer to paragraph 3-6b and reverse disassembly instructions for assembly of pinion housing assembly.

b. *Installation.* Refer to paragraph 3-6a and reverse removal instructions for installation of pinion housing assembly. Make certain alignment marks (A, fig. 3-5) on shift and pinion housing are properly aligned.

**NOTE**

The same starter assembly is used on both the LDS-465, LDT-465, LD-465 and



MACK Model ENDT 673 engines. However, the pinion housing is positioned differently for certain engine application. Figure 3-40 illustrates position for LDS-465-1, LDS-465-1A and MACK Model ENDT 673 engine applications, figure 3-41 illustrates position for LD-465-1, LD-465-1C and LDT-465-1C engine applications, and figure 3-42 illustrates position for LDS-465-2 engine applications.

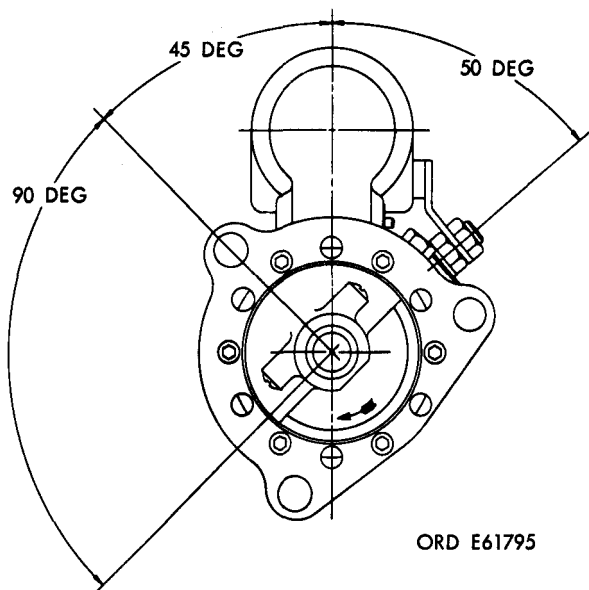


Figure 3-40. Pinion housing position for LDS-456-1, LDS-465-1A and MACK Model ENDT 673 engine applications.

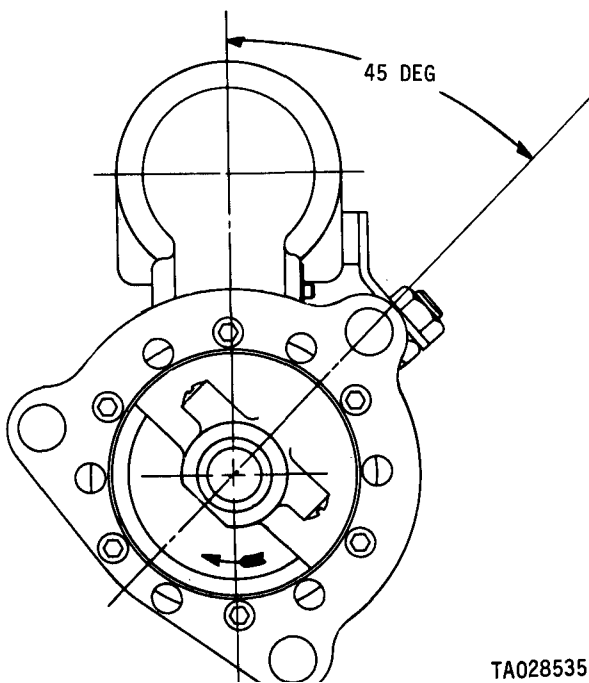


Figure 3-41 Pinion housing position for LD-465-1, LD-465-1C and LDT-465-1C engine applications.

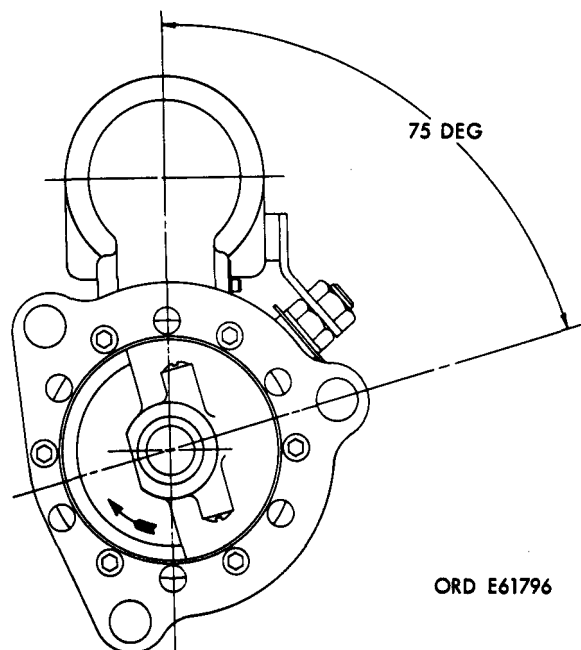


Figure 3-42. Pinion housing position for LDS-465-2 engine application.

### 3-25. Installation of Solenoid Relay Assembly

a. Place relay assembly (C, fig. 3-4) on field ring and guide shaft, and insert assembly (fig. 3-9) through seal in relay cover. Make certain shaft enters plunger so threaded end of shaft is alined with hole in plunger.

b. Insert shaft adjusting tool (A, fig. 3-4) and engage end of tool with end of adjusting shaft. Turn tool clockwise to engage plunger with shaft and insert assembly (fig. 3-9). Turn tool eight complete turns.

c. Move relay so that it alines with mounting holes in field ring and secure with two hex-head bolts (A, fig. 3-3).

d. Using shaft adjusting tool (A, fig. 3-4) turn adjusting shaft clock wise eight additional turns.

e. Apply 24 volts direct current across terminals 1 and 3.

#### NOTE

Terminals are numbered with raised numerals on the relay cover.

#### CAUTION

Never leave relay energized any longer than necessary to check clearance. Also, never make adjustment when relay is energized.

f. Refer to figure 3-43. Gently push drive assembly back against arm and measure



clearance. It should be 0.187-inch. If not, refer to fig. 3-4, use the adjusting tool and turn adjusting

shaft clockwise to decrease clearance, and counterclockwise to increase clearance.

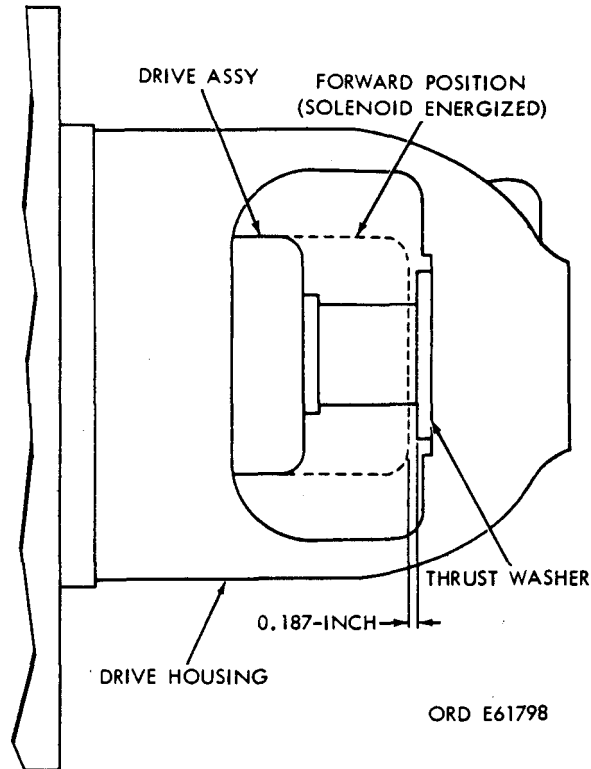


Figure 3-43. Measuring drive clutch pinion clearance.

## Section IV. TESTS AND ADJUSTMENTS

### 3-26. General

Whenever a starter is tested, it should be checked for any unusual noises or vibration that might indicate an unserviceable condition. If either

condition exists, repair the starter without further testing.

### 3-27. No-Load Test

a. Connect starter into test arrangement as shown in figure 3-44.

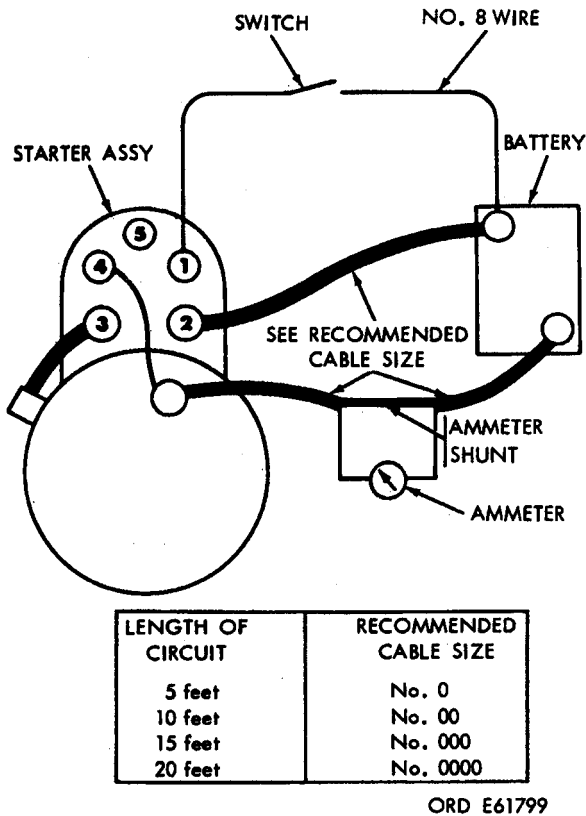


Figure 3-44. Starter test setup.

b. Close switch and measure current draw and armature speed. Current draw should be 50 amps

maximum and armature speed should be 6500 rpm minimum.

c. If a low speed and high current condition exists, check armature for excessive arcing, grounds, and shorts. Also examine starter for armature drag. If drag exists, check for loose pole shoe screws and tighten as necessary; or, disassemble starter and check for armature eccentricity or faulty bearings.

d. If low speed and low current condition exist, inspect starter for faulty connections and for poor brush contact.

**3-28. DELETED.**

**3-29. Waterproof Test**

a. Place waterproof adapter over pinion housing. Install adapter and apply 6 psi air pressure.

b. Allow pressure to build up and then submerge starter in a suitable water tank.

c. Check for air leaks evidenced by bubbles. No leakage is permitted.

d. If leaks are present, disassemble starter, install new packings and gaskets. Coat packings and gasket with grease before installation and apply sealer to all external screws and pipe plugs. Assemble starter and retest for leaks.

**Section V. REPAIR STANDARDS**

**3-30. General**

The repair standards listed in paragraph 3-31 give maximum, minimum, and key clearances of new or rebuilt parts. They also give wear limits, which indicate the point to which a part or parts may be worn before replacement, for maximum service with minimum replacement. Normally, all parts which have not been worn beyond dimensions shown in "Wear limits" column or damaged from corrosion will be

approved for service. An asterisk (\*) in the "Wear limits" column should be replaced when worn beyond limits given in "Sizes and fits of new parts" column. In "Sizes and fits of new parts" column, "L" indicates a loose fit and "T" indicates a tight fit. All dimensions are given in inches unless otherwise specified.

**3-31. Wear Limits**

All reference letters are keyed to figure B-2.

*a. Armature Assembly, Bearings, and Drive Assembly,*

Reference letter	Point of measurement	Sizes and fits of new parts	Wear limits
<b>b</b>	OD of drive end of armature shaft	0.7465 to 0.7470	0.7469
<b>c</b>	Armature commutator diameter	2.125 to 2.140	2.0000
<b>d</b>	OD of commutator end of armature shaft	0.7495 to 0.7500	0.7490
<b>e</b>	Brush length	0.8125	0.312
<b>f</b>	OD of lever housing bearing surface-of armature shaft	0.8645 to 0.8650	0.8640
<b>h</b>	Spring pressure at end of 0.400-in. travel	18 lbs	
<b>b. Lever and Lever Shaft.</b>			
<b>A</b>	Diameter of lever shaft hole	0.5020 to 0.5050	0.5100
<b>g</b>	OD of lever shaft	0.4950 to 0.5010	0.4850
<b>A-g</b>	Fit of shaft in lever	0.0010L to 0.0100L	0.025L
<b>c. Brush Rigging Assembly.</b>			
<b>i</b>	OD of bearing	0.002 to 1.003	*
<b>j</b>	Diameter of bearing bore in commutator end housing	0.998 to 1.000	*
<b>i-j</b>	Fit of bearing in housing	0.001T to 0.005T	*
<b>k</b>	ID of bearing	0.752 to 0.754	0.7595
<b>d-k</b>	Fit of armature shaft in bearing	0.0020L to 0.0045L	0.0090L
<b>d. Pinion Housing Assembly.</b>			
<b>M</b>	OD of bearing	1.002 to 1.003	*
<b>N</b>	Diameter of bearing bore in pinion housing	0.999 to 1.001	*
<b>M-N</b>	Fit of bearing in housing	0.001T to 0.004T	*
<b>P</b>	ID of bearing	0.749 to 0.751	0.7560
<b>b-P</b>	Fit of armature shaft in bearing	0.0020L to 0.0045L	0.0090L
<b>e. Shift Housing Assembly.</b>			
<b>R</b>	OD of bearing	1.127 to 1.128	*
<b>s</b>	ID of bearing	0.874 to 0.876	0.8810
<b>f-S</b>	Fit of armature shaft in bearing	0.0090L to 0.0115L	0.0155L
<b>T</b>	Diameter of bearing bore in shift housing (hidden)	1.124 to 1.126	*
<b>R-T</b>	Fit of bearing in shift housing	0.001T to 0.004T	*



## APPENDIX A

### REFERENCES

#### A-1. Publications Indexes

The following indexes should be consulted frequently for latest changes or revisions of references given in this appendix and for new publications relating to materiel covered in this technical manual.

Index of Army Motion Pictures and Related Audio-Visual Aids . . . . .	DA Pam 108-1
Military Publications:	
Index of Administrative Publications . . . . .	DA Pam 310-1
Index of Blank Forms . . . . .	DA Pam 310-2
Index of Doctrinal Training and Organizational Publications . . . . .	DA Pam 310-3
Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 7, 8, and 9), Supply Bulletins, and Lubrication Orders . . . . .	DA Pam 310-4

#### A-2. Publications References

The Army Maintenance Management System (TAMMS) . . . . .	TM 38-750
Organizational Maintenance Manual for 2Y-½ Ton, 6x6 Chassis, Truck: M44, M44A1, M44A2, M45, M45A1, M45A2, M45A2G, M45C, M45G, M46, M46A1, M46A1C, M46A2C, M46C, M57, M58; Instrument Repair Shop, Truck Mounted: M185, M185A1, M185A2, M185A3; Truck, Cargo: M34, M35, M35A1, M35A2, M35A2C, M36, M36A2, M36C; Truck, Dump: M47, M59, M342, M342A2; Truck, Maintenance: Earth Boring Machine and Pole Setter, V18A/MTQ, M764; Truck, Maintenance: Telephone Construction and Maintenance V17A/MTQ; Truck, Tank: Fuel Servicing, 1,200-Gal., M49, M49C, M49A1C, M49A2C; Truck, Tank: Water, 1,000-Gal., M50, M50A1, M50A2, M50A3; Truck, Tractor: M48, M275, M275A1, M275A2; Truck, Van: Electronic, M567; Truck, Van: Expansibile, M292, M292A1, M292A2, M292A5; Truck, Van: Shop, M109, M109A1, M109A2, M109A3; Truck, Wrecker: Crane, M108; Truck, Wrecker: Light, M60; Truck, Pipeline Construction, M756A2 . . . . .	TM 9-2320-209-20
Organizational Maintenance Manual for Truck, Chassis: 5-Ton, 6x6, M39, M39A2, M40, M40A1, M40A2, M40A1C, M40A2C, M61, M61A1, M61A2, M63, M63A1, M63A2, M63C, M63A1C, M63A2C, M63A1D, M63A2D, M139A1, M139A2, M139C, M139A2C, M139D, M139A2D, M139F, M139A1F, M139A2F; Truck, Cargo: M41, M41A2, M54, M54A1, M54A2, M54A1C, M54A2C, M55, M55A1, M55A2; Truck, Dump: M51, M51A1, M51A2; Truck, Tractor: M52, M52A1, M52A2; Truck, Tractor, Wrecker: M246, M246A1, M246A2; Truck, Van, Expansibile: M291A1, M291A2, M291A1C, M291A2C, M291A1D, M291A2D; Truck, Wrecker, Medium: M62, M543, M543A1, M543A2; Truck, Bridging: M139, M328A1, M328A2; Truck, Logging, M748A1, M748A2 . . . . .	TM 9-2320-211-20
Organizational Maintenance Manual: Truck, Cargo: 5-Ton, 8x8, M656 W/Winch (FSN 2320-999-8418) Truck, Cargo: 5-Ton, 8x8, M656 W/O Winch (FSN 2320-903-0883) Truck, Tractor: 5-Ton, 8x8, XM757 W/Winch (FSN 2320-937-1846) Truck, Tractor: 5-Ton, 8x8, XM757 W/O Winch (FSN 2320-937-1445) Truck, Van, Expansibile: 5-Ton, 8x8, XM791 W/Winch (FSN 2320-832-5619) Truck, Van, Expansibile: 5-Ton, 8x8, XM791 W/O Winch (FSN 2320-832-5620) . . . . .	TM 9-2320-230-20
Direct Support and General Support: Quality Control Inspectors Inspection Criteria	TM 750-245-4



## APPENDIX B

## REPAIR PARTS AND SPECIAL TOOLS LIST

## Section I. INTRODUCTION

**B-1. Scope**

This appendix lists repair parts required for the performance of direct support and general support maintenance of the Electrical Engine Starter Assembly.

**B-2. General**

This Repair Parts and Special Tools List is divided into the following sections:

*a. Section II. Repair Parts List.* A list of repair parts authorized for use in the performance of maintenance. The list also includes parts which must be removed for replacement of the authorized parts. Parts lists are composed of functional groups in ascending numerical sequence, with the parts in each group listed in figure and item number sequence. Bulk materials are listed in NSN sequence.

*b. Section III. Special Tools List.* A list of special tools, TMDE, and support equipment authorized for the performance of maintenance at the organizational level.

*c. Section IV. National/NATO Stock Number and Part Number Index.* A list, in ascending numerical sequence, of all National/NATO stock numbers appearing in the listings, followed by a list, in alphameric sequence, of all part numbers appearing in the listings. National/NATO stock number and part numbers are cross-referenced to each illustration figure and item number appearance. This index is followed by a cross-reference list of reference designations to figure and item numbers when applicable.

**B-3. Explanation of Columns**

The following provides an explanation of columns found in the tabular listings:

*a. Illustration.* This column is divided as follows:

(1) *Figure number.* Indicates the figure number of the illustration in which the item is shown.

(2) *Item number.* The number used to identify each item called out in the illustration.

*b. Source, Maintenance, and Recoverability Codes (SMR).*

(1) *Source code.* Source codes are assigned to support items to indicate the manner of acquiring

support items for maintenance, repair, or overhaul of end items. Source codes are entered in the first and second positions of the Uniform SMR Code format as follows:

<i>Code</i>	<i>Definition</i>
PA	Item procured and stocked for anticipated or known usage.
PB	Item procured and stocked for insurance purpose because essentiality dictates that a minimum quantity be available in the supply systems.
PC	Item procured and stocked and which otherwise would be coded PA except that it is deteriorative in nature.
PD	Support item, excluding support equipment, procured for initial issue or outfitting and stocked only for subsequent or additional initial issues or outfittings. Not subject to automatic replenishment.
PE	Support equipment procured and stocked for initial issue or outfitting to specified maintenance repair activities.
PF	Support equipment which will not be stocked but which will be centrally procured on demand.
PG	Item procured and stocked to provide for sustained support for the life of the equipment. It is applied to an item peculiar to the equipment which, because of probable discontinuance or shutdown of production facilities, would prove uneconomical to reproduce at a later time.
KD	An item of a depot overhaul/repair kit and not purchased separately. Depot kit defined as a kit that provides items required at the time of overhaul or repair.
KF	An item of a maintenance kit and not purchased separately. Maintenance kit defined as a kit that provides an item that can be replaced at organizational or intermediate levels of maintenance.
KB	Item included in both a depot overhaul/repair kit and a maintenance kit.
MO	Item to be manufactured or fabricated at organizational level.
MF	Item to be manufactured or fabricated at the direct support maintenance level.
MH	Item to be manufactured or fabricated at the general support maintenance level.
MD	Item to be manufactured or fabricated at the depot maintenance level.
AO	Item to be assembled at organizational level.
AF	Item to be assembled at direct support maintenance level.
AH	Item to be assembled at general support maintenance level.
AD	Item to be assembled at depot maintenance level.

<i>Code</i>	<i>Definition</i>
XA	Item is not procured or stockea because the requirements for the item will result in the replacement of the next higher assembly.
XB	Item is not procured or stocked. If not available through salvage, requisition.
XD	A support item that is not stocked. When required, item will be procured through normal supply channels.

**NOTE**

Cannibalization or salvage may be used as a source of supply for any items source coded above except those coded XA, XD, and aircraft support items as restricted by AR 700-42.

(2) *Maintenance code.* Maintenance codes are assigned to indicate the levels of maintenance authorized to USE and REPAIR support items. The maintenance codes are entered in the third and fourth position of the Uniform SMR Code format as follows:

(a) The maintenance code entered in the third position will indicate the lowest maintenance level authorized to remove, replace, and use the support item. The maintenance code entered in the third position will indicate one of the following levels of maintenance:

<i>Code</i>	<i>Application/Explanation</i>
C	Crew or operator maintenance performed within organizational maintenance.
O	Support item is removed, replaced, used at the organizational level.
F	Support item is removed, replaced, used at the direct support level.
H	Support item is removed, replaced, used at the general support level.
D	Support items that are removed, replaced, used at depot, mobile depot, specialized repair activity only.

(b) The maintenance code entered in the fourth position indicates whether the item is to be repaired and identifies the lowest maintenance level with the capability to perform complete repair (i.e., all authorized maintenance functions). This position will contain one of the following maintenance codes:

<i>Code</i>	<i>Application/Explanation</i>
O	The lowest maintenance level capable of complete repair of the support item is the organizational level.
F	The lowest maintenance level capable of complete repair of the support item is the direct support level.
H	The lowest maintenance level capable of complete repair of the support item is the general support level.
D	The lowest maintenance level capable of complete repair of the support item is the depot level, performed by depot, mobile depot or specialized repair activity.
L	Repair restricted to designated specialized repair activity.

<i>Code</i>	<i>Application/Explanation</i>
Z	Nonreparable. No repair is authorized.
B	No repair is authorized. The item may be reconditioned by adjusting, lubricating, etc., at the user level. No parts special tools are procured for the maintenance of this item.

(3) *Recoverability code.* Recoverability codes are assigned to support items to indicate the disposition action on unserviceable items. The recoverability code is entered in the fifth position of the Uniform SMR Code format as follows:

*Recoverability*

<i>Codes</i>	<i>Definition</i>
Z	Nonreparable item. When unserviceable, condemn and dispose at the level indicated in position 3.
O	Reparable item. When uneconomically repairable, condemn and dispose at organizational level.
F	Reparable item. When uneconomically repairable, condemn and dispose at the direct support level.
H	Reparable item. When uneconomically repairable, condemn and dispose at the general support level.
D	Reparable item. When beyond lower level repair capability, return to depot. Condemnation and disposal not authorized below depot level.
L	Reparable item. Repair, condemnation, and disposal not authorized below depot/specialized repair activity level.
A	Item requires special handling or condemnation procedures because of specific reasons (i.e., precious metal content, high dollar value, critical material or hazardous material). Refer to appropriate manuals/directives for specific instructions.

*c. National/NATO Stock Number.* Indicates the National/NATO stock number assigned to the item and will be used for requisitioning purposes.

*d. Part Number.* Indicates the primary number used by the manufacturer (individual, company, firm, corporation, or Government activity), which controls the design and characteristics of the item by means of its engineering drawings, specifications standards, and inspection requirements, to identify an item or range of items.

**NOTE**

When a stock numbered item is requisitioned, the repair part received may have a different part number than the part being replaced.

*e. Federal Supply Code for Manufacturer (FSCM).* The FSCM is a 5-digit numeric code listed in SB 708-42 which is used to identify the manufacturer, distributor, or Government agency, etc.

*f. Description.* Indicates the Federal item name and, if required, a minimum description to identify the item. Items that are included in kits and sets are listed below the name of the kit or set with quantity of each item in the kit or set indicated in



the quantity incorporated in unit column. When the part to be used differs between serial numbers of the same model, the effective serial numbers are shown as the last line of the description. In the Special Tools List, the initial basis of issue (BOI) appears as the last line in the entry for each special tool, TMDE, and support equipment. When density of equipment supported exceeds density spread indicated in the basis of issue, the total authorization is increased accordingly.

*g. unit of Measure (U/M).* Indicates the standard of the basic quantity of the listed item as used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e. g., ea, in, pr, etc.). When the unit of measure differs from the unit of issue, the lowest unit of issue that will satisfy the required units of measure will be requisitioned.

*h. Quantity Incorporated in Unit.* Indicates the quantity of the item used in the breakout shown on the illustration figure, which is prepared for a functional group, subfunctional group, or an assembly. A "V" appearing in this column in lieu of a quantity indicates that no specific quantity is applicable, (e.g., shims, spacers, etc.).

**B-4. Special Information**

*a. End item application:*

- Engine, diesel (Multi-Fuel)
  - 6-cylinder Military Model LDT-465-1C
  - 6-cylinder Military Model LD-465-1
  - 6-cylinder Military Model LDS-465-1
  - 6-cylinder Military Model LDS-465-1A
  - 6-cylinder Military Model LD-465-1C
  - 6-cylinder Military Model LDS-465-2
  - 6-cylinder Military Model MACK Model ENDT 673

*b.* Repair parts kits and gasket sets appear as the last entries in the repair parts listing for the figure in which its parts are listed as repair parts.

*c.* Action change codes indicated in the left-hand margin of the listing page denote the following:

- N-Indicates an added item
- C-Indicates a change in data
- R-Indicates a change in NSN only

*d.* Special Tool Sets are stocked for initial issue. Tool Set components are requisitioned as individual items. Stockage of tools that are duplicated in tool sets for other vehicles assigned or supported are not required beyond actual need.

**B-5. How to Locate Repair Parts**

*a. When Federal Stock Number or Part Number is Unknown:*

(1) *First.* Using the table of contents, determine the functional group within which the repair part belongs. This is necessary since illustrations are prepared for functional groups and listings are divided into the same groups.

(2) *Second.* Find the illustration covering the functional group to which the repair part belongs.

(3) *Third.* Identify the repair part on the illustration and note the illustration figure and item number of the repair part.

(4) *Fourth.* Using the Repair Parts Listing, find the figure and item number noted on the illustration.

*b. When National/NATO Stock Number or Part Number is Known.*

(1) *First.* Using the Index of National/NATO Stock Numbers, find the pertinent National/NATO stock number or part number. This index is in ascending NSN sequence followed by a list of part numbers in ascending alphameric sequence, cross-referenced to the illustration figure number and item number.

(2) *Second.* After finding the figure and item number, locate the figure and item number in the repair parts list.

**B-6. Abbreviations.**

- N.I . . . . . Not Illustrated
- EA . . . . . Each

## Section II. REPAIR PARTS LIST

	(1) Illustration		(2) SMR CODE	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION  <i>USABLE ON CODE</i>	(7) U/M	(8) QTY INC IN UNIT
	(a) FIG NO.	(b) ITEM NO.							
							GROUP 06—ELECTRICAL SYSTEM 0603—STARTING MOTOR		
C	B-1		PAOFF	2920-00-267-9987	10935376	19207	STARTER, ENGINE, ELECTRICAL: Leece-Neville Model M001707072MB	EA	1
C	B-2	1	XA		73566	35510	HOUSING, NOSE, STARTING MOTOR: pinion assembly	EA	1
C	B-2	2	PAFZZ	4730-00-843-0463	Z083021293	35510	PLUG, PIPE: pinion housing (1) shift housing (1) brush rigging assembly (2)	EA	4
C	B-2	3	KFFZZ		Z096071059	35510	BEARING: pinion housing (1) brush rigging assembly (1) (Part of KIT, P/N 5702711 (19207))	EA	2
C	B-2	4	PAFZZ	9390-00-112-8047	38406	35510	WICK: pinion housing (1) shift housing (1) brush rigging assembly (1)	EA	3
C	B-2	5	XA		M005073566	35510	HOUSING: pinion assembly	EA	1
N	B-2	6	KFFZZ		MS9068-152	96906	PACKING, PREFORMED (Part of KIT, P/N 5702714 (19207) and KIT, P/N 5702745 (19207))	EA	1
N	B-2	7	KFFZZ		Z095071045	35510	WASHER, THRUST (Part of KIT, P/N 5702712 (19207))	EA	2
N	B-2	8	KFFZZ		11602684	19207	DRIVE (Part of KIT, P/N 5702745 (19207))	EA	1
N	B-2	9	KFFZZ		Z082071044	35510	WASHER, THRUST (Part of KIT, P/N 5702712 (19207))	EA	3
C	B-2	10	XBFZZ		73517	35510	LEVER, ARM: starting actuator shaft	EA	1
C	B-2	11	XBFZZ		73515	35510	PIN: lever arm to shaft and insert assembly	EA	2
C	B-2	12	XBFZZ		73516	35510	COUPLING: lever arm to shaft	EA	1
C	B-2	13	XBFZZ		73524	35510	SHAFT AND INSERT ASSEMBLY	EA	1
N	B-2	14	KFFZZ		MS28775-134	96906	PACKING, PREFORMED (Part of KIT, P/N 5702714 (19207))	EA	1
C	B-2	15	XBFZZ		M165073565	35510	HOUSING, SHIFT: starter assembly	EA	1
N	B-2	16	KFFZZ		8738057	19207	SEAL, OIL (Part of KIT P/N 5702714 (19207))	EA	1
N	B-2	17	KFFZZ		Z096071060	35510	BEARING: shift housing (Part of KIT P/N 5702711 (19207))	EA	1
N	B-2	18	KFFZZ		MS9068-156	96906	PACKING, PREFORMED (Part of KIT P/N 5702714 (19207))	EA	2
C	B-2	19	XBFZZ		73503	35510	SCREW: relay-solenoid to frame	EA	2
C	B-2	20	PAOZZ	2920-00-757-2746	8738050	19207	RELAY-SOLENOID, ENGINE: starter assembly	EA	1
C	B-2	21	PAOZZ	5310-00-582-5965	MS35338-44	96906	WASHER: relay-solenoid terminal	EA	8
C	B-2	22	XBFZZ		Z099002325	35510	NUT: relay-solenoid terminal	EA	2
C	B-2	23	XBFZZ		Z098073450	35510	NUT: relay-solenoid (2) starter terminal (2)	EA	4
C	B-2	24	PAOZZ	2920-00-411-8327	M047073496	35510	JUMPER, STARTER SOLENOID: relay terminal to field terminal	EA	1
C	B-2	25	PAFZZ	2920-00-453-5349	M026073564	35510	BAND: brush opening	EA	1
C	B-2	26	PAFZZ	5310-00-982-4937	MS27040-8	96906	NUT, PLAIN, SQUARE: brush opening band	EA	2
N	B-2	27	KFFZZ		Z095071042	35510	WASHER, THRUST (Part of KIT, P/N 5702712 (19207))	EA	1
C	B-2	28	XA		8738047	19207	ARMATURE, MOTOR: starter assembly	EA	1
N	B-2	29	KFFZZ		Z082071046	35510	WASHER, THRUST (Part of KIT, P/N 5702712 (19207))	EA	1
C	B-2	30	XA		M047038436	35510	COIL, JUMPER: brush rigging assembly	EA	1
C	B-2	31	PAFZZ	2920-00-058-6608	57817	35510	JUMPER ASSEMBLY, STARTER: jumper and screw	EA	1

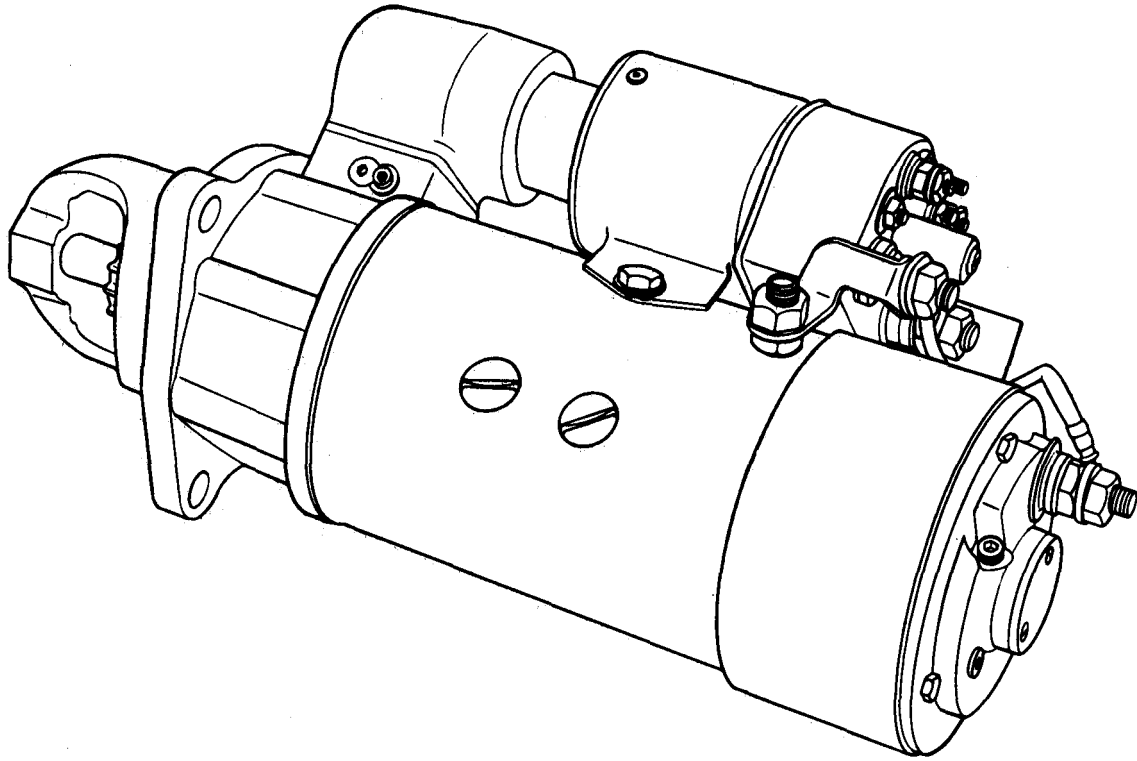
	(1) Illustration		(2) SMR CODE	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION  <i>USABLE ON CODE</i>	(7) U/M	(8) QTY INC IN UNIT
	(a) FIG NO.	(b) ITEM NO.							
							0000—STARTING MOTOR—Continued		
C	B-2	32	PAFZZ	5365-00-734-6198	55662	35510	BUSHING, RUBBER: jumper screw	EA	2
C	B-2	33	PAFZZ	5330-00-633-6976	73575	35510	PACKING, PREFORMED: jumper screw	EA	1
C	B-2	34	XBFZZ		M011073579	35510	HOUSING: brush rigging assembly	EA	1
C	B-2	35	XA		73512	35510	LEAD, ELECTRICAL CONTACT: starter terminal	EA	1
C	B-2	36	XBFZZ		01614	35510	WASHER: starter terminal	EA	1
C	B-2	37	XBFZZ		Z093001613	35510	WASHER: starter terminal	EA	2
C	B-2	38	PAFZZ	5305-00-068-0502	MS90725-6	96906	SCREW, CAP, HEXAGON XEAD: brush rigging assembly to frame assembly	EA	4
C	B-2	39	PAFZZ	5305-00-855-0967	MS24629-37	96906	SCREW, TAPPING, THREAD: cover plate	EA	3
C	B-2	40	XA		M163073585	35510	PLATE, COVER: brush rigging assembly	EA	1
N	B-2	41	KFFZZ		8738058	19207	GASKET, BRUSH SPRING (Part of KIT, P/N 5702714 (19207))	EA	1
C	B-2	42	PAFZZ	5977-00-758-9555	5702695	19207	BRUSH SET, ELECTRICAL CONTACT: set of 8 brushes	EA	1
C	B-2	43	XA		M119057022	35510	PLATE, LOCK: brush	EA	4
C	B-2	44	PAFZZ	5305-00-855-0967	MS24629-37	96906	SCREW, TAPPING, THREADED: brush lock plate	EA	8
C	B-2	45	PAFZZ	5310-00-732-4986	52722	35510	WASHER, FLAT: brush holder support	EA	12
C	B-2	46	XBFZZ		52720	35510	HOLDER ASSEMBLY: brush and spring	EA	4
C	B-2	47	PAFZZ	5970-00-731-9667	38426	35510	INSULATOR, BUSHING: brush holder support	EA	4
C	B-2	48	XBFZZ		05291	35510	WASHER, FLAT: brush holder	EA	4
C	B-2	49	XBFZZ		57036	35510	WASHER, LOCK: brush holder supports	EA	4
C	B-2	50	PAFZZ	5305-00-016-9519	57035	35510	SCREW, TAPPING, THREADED: brush holder supports	EA	4
C	B-2	51	PAFZZ	5305-00-984-6192	MS35206-266	96906	SCREW, TAPPING, THREADED: brush opening band	EA	2
C	B-2	52	XA		M025073580	35510	INSULATOR: field ring	EA	1
C	B-2	53	XA		Z152022588	35510	SCREW: nameplate to frame	EA	2
C	B-2	54	XA		M019073614	35510	NAMEPLATE: starter assembly	EA	1
C	B-2	55	XA		M016073572	35510	FIELD RING ASSEMBLY: electrical engine	EA	1
C	B-2	56	PAFZZ	2920-00-482-1999	36900	35510	WASHER, FLAT: lever shaft	EA	1
C	B-2	57	PAFZZ	5305-00-983-7428	MS16998-26	96906	SCREW, CAP, SOCKET, HEAD: lever shaft retainer	EA	1
N	B-2	58	KFFZZ		MS28775-102	96906	PACKING, PREFORMED (Component of KIT, P/N 5702714 (19207))	EA	1
C	B-2	59	XA		M777073587	35510	SHAFT: shift lever retaining	EA	1
C	B-2	60	PAFZZ	5305-00-987-9385	MS16997-62	96906	SCREW, CAP, SOCKET HEAD: pinion housing	EA	6
C	B-2	61	XBFZZ		31757	35510	SCREW, CAP, SOCKET HEAD: shift housing	EA	6
C	B-2	62	XA		M089073571	35510	PLUG, SEAL: pinion housing	EA	6
C	B-2		PAFZZ	2920-00-089-3386	5702714	19207	PARTS KIT: gasket and seal	EA	1
C	B-2	6	KFFZZ		MS9068-152	96906	PACKING	EA	1
C	B-2	14	KFFZZ		MS28775-134	96906	PACKING	EA	1
C	B-2	16	KFFZZ		8738057	19207	SEAL	EA	1
C	B-2	18	KFFZZ		MS9068-156	96906	PACKING	EA	2
C	B-2	41	KFFZZ		8738058	19207	GASKET	EA	1
C	B-2	58	KFFZZ		MS28775-012	96906	PACKING	EA	1
C	B-2	NI	KFFZZ		S054071063	35510	SEAL (Not used on this starter)	EA	1
C	B-2		PAFZZ	3120-00-089-2707	5702711	19207	PARTS KIT: sleeve bearing	EA	1
C	B-2	3	KFFZZ		Z096071059	35510	BEARING	EA	2

TM 9-2920-243-34

	(1) Illustration		(2) SMR CODE	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) FSCM	(6) DESCRIPTION  <i>USABLE ON CODE</i>	(7) U/M	(8) QTY INC IN UNIT
	(a) FIG NO.	(b) ITEM NO.							
							<i>600-STARTING MOTOR-Continued</i>		
C	B-2	17	KFFZZ		Z096071060	35510	BEARING	EA	1
C	B-2		PAFZZ	2920-00-089-2706	5702712	19207	PARTS, KIT ELECTRICAL ENGINE STARTER: thrust washer set	EA	1
C	B-2	7	KFFZZ		Z095071045	35510	WASHER	EA	2
C	B-2	9	KFFZZ		Z082071044	35510	WASHER	EA	3
C	B-2	27	KFFZZ		Z095071042	35510	WASHER	EA	1
C	B-2	29	KFFZZ		Z082071046	35510	WASHER	EA	1
C	B-2		PAFZZ	2920-060-7252	5702745	19207	PARTS KIT, STARTER DRIVE	EA	1
C	B-2	8	KFFZZ		11602684	19207	DRIVE	EA	1
C	B-2	6	KFFZZ		MS9068-152	96906	PACKING	EA	1
C	B-2		KFFZZ		11601617	19207	GASKET	EA	1
C	B-2		KFFZZ		MS28775-236	96906	(Not used on this starter) PACKING	EA	1
C	B-2		KFFZZ		10951127	19207	(Not used on this starter) WASHER	EA	1
C	B-2		KFFZZ		10917157	19207	(Not used on this starter) GASKET	EA	1
C	B-2		KFFZZ		7748635	19207	(Not used on this starter) GASKET	EA	1
C	B-2		KFFZZ		482204	72850	(Not used on this starter) BUSHING	EA	1
C	B-2		KFFZZ		11610014	19207	(Not used on this starter) WASHER	EA	1

### Section III. SPECIAL TOOLS

(1) Illustration		(2)	(3)	(4)	(5)	DESCRIPTION	U/M	QTY INC IN UNIT
(a) FIG NO.	(b) ITEM NO.	SMR CODE	NATIONAL STOCK NUMBER	PART NUMBER	FSCM	<i>USABLE ON CODE</i>		
C	D 2	DAE77	00	10935617	19207	2604—SPECIAL TOOLS TOOL: shaft adjusting	EA	1



AT 39070

*Figure B-1. Electrical engine starter assembly.*

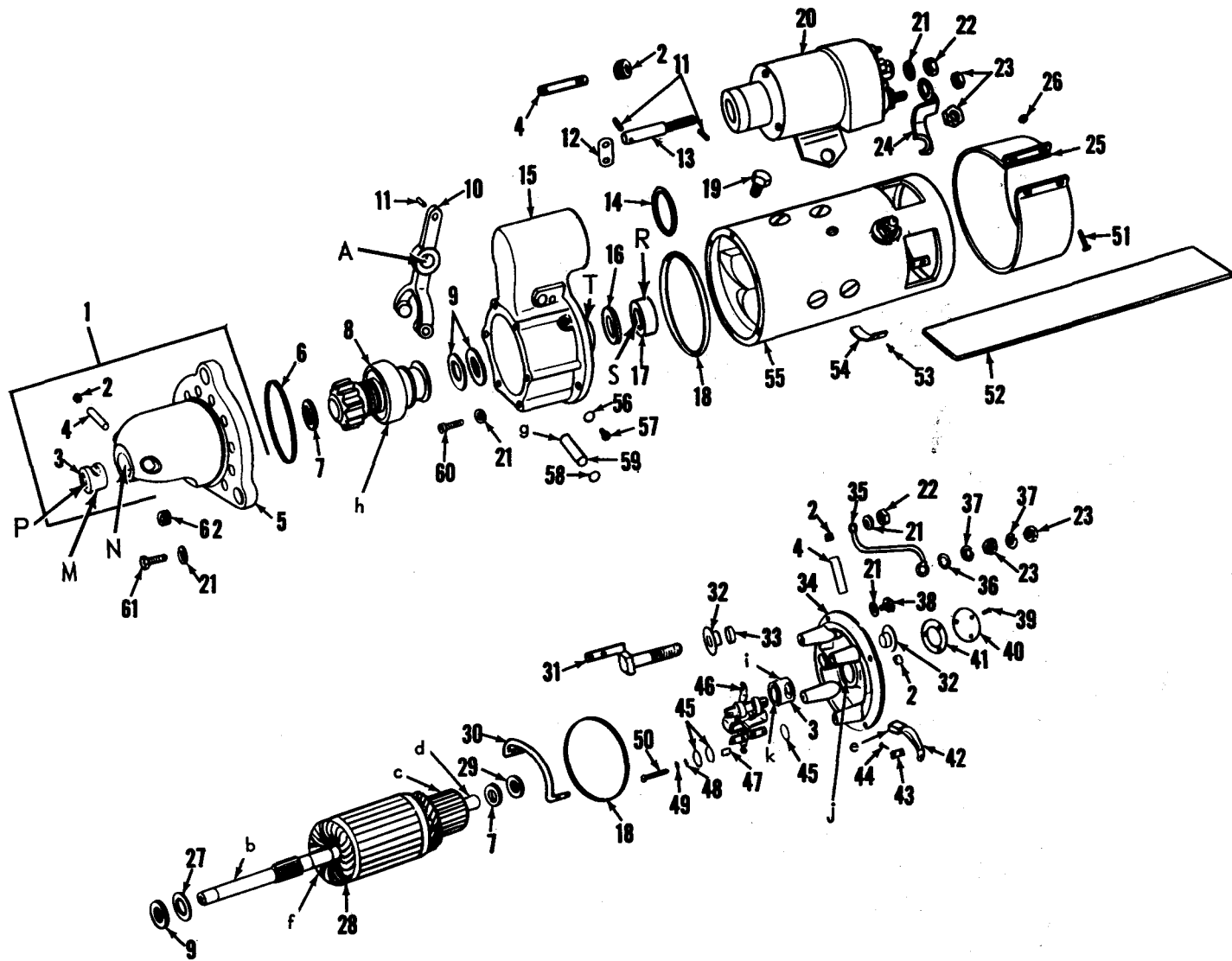
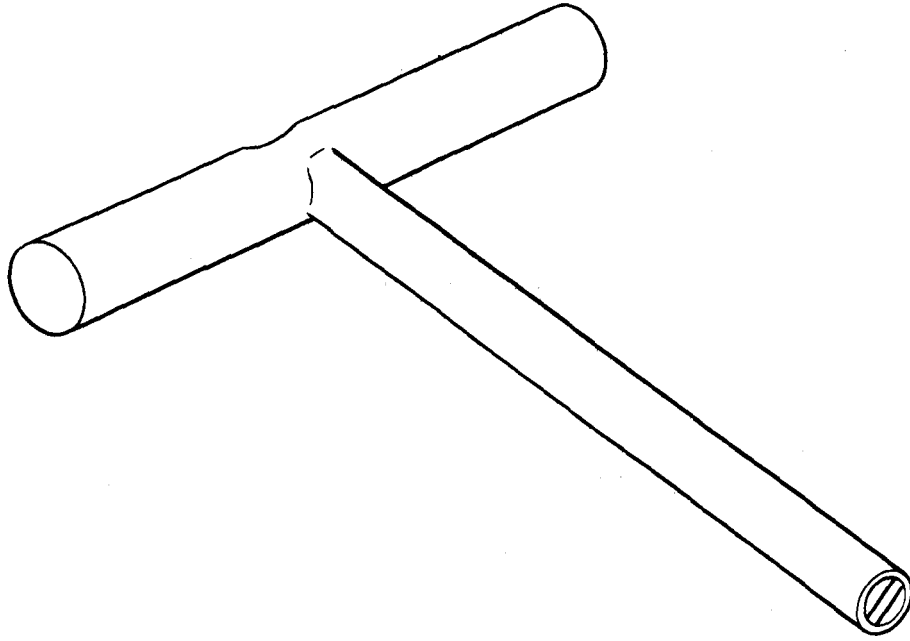


Figure B-2. Starter assembly—exploded view.



AT 39072

*Figure B-3. Special tool.*



Section IV. NATIONAL/NATO STOCK NUMBER AND PART NUMBER INDEX

National/NATO Stock Number Cross-Reference to Figure and Item Number

National/NATO stock number	Figure No.	Item No.	National/NATO stock number	Figure No.	Item No.
2920-00-058-6608	B-1	31	5305-00-855-0967	B-2	39
2920-00-060-7252	B-2	KIT			44
2920-00-089-2706	B-2	KIT	5305-00-978-9385	B-2	60
2920-00-089-3386	B-2	KIT	5305-00-983-7428	B-2	57
2920-00-267-9987	B-1		5305-00-984-6192	B-2	51
2920-00-411-8327	B-2	24	5310-00-582-5965	B-2	21
2920-00-453-5349	B-2	25	5310-00-732-4986	B-2	45
2920-00-482-1999	B-2	56	5310-00-982-4937	B-2	26
2920-00-757-2746	B-2	20	5330-00-633-6976	B-2	33
3120-00-089-2707	B-2	KIT	5365-00-734-6198	B-2	32
4730-00-843-0463	B-2	2	5970-00-731-9667	B-2	47
4910-00-792-8626	B-3		5977-00-758-9555	B-2	42
5305-00-016-9519	B-2	50	9390-00-112-8047	B-2	4
5305-00-068-0502	B-2	38			

Part Number Cross-Reference to Figure and Item Number

Reference No.	Mfg.Code	Fig.No.	Item No.	Reference No.	Mfg.Code	Fig.No.	Item No.
M005073566	35510	B-2	5	Z099002325	35510	B-2	22
M011073579	35510	B-2	34	Z152022588	35510	B-2	53
M016073572	35510	B-2	55	01614	35510	B-2	36
M019073614	35510	B-2	54	05291	35510	B-2	48
M025073580	35510	B-2	52	10935376	19207	B-1	
M026073564	35510	B-2	25	10935617	19207	B-3	
M047038436	35510	B-2	30	11602684	19207	B-2	8
M047073496	35510	B-2	24	31757	35510	B-2	61
M089073571	35510	B-2	62	36900	35510	B-2	56
M119057022	35510	B-2	43	38406	35510	B-2	4
M163073585	35510	B-2	40	38426	35510	B-2	47
M165073565	35510	B-2	15	505471063	35510	B-2	63
M777073587	35510	B-2	59	52720	35510	B-2	46
MS16997-62	96906	B-2	60	52722	35510	B-2	45
MS16998-26	96906	B-2	57	55662	35510	B-2	32
MS24629-37	96906	B-2	39	5702695	35510	B-2	42
			44	5702711	19207	B-2	KIT
MS27040-8	96906	B-2	26	5702712	19207	B-2	KIT
MS28775-012	96906	B-2	58	5702714	19207	B-2	KIT
MS28775-134	96906	B-2	14	5702745	19207	B-2	KIT
MS35206-266	96906	B-2	51	57035	35510	B-2	50
MS35338-44	96906	B-2	21	57036	35510	B-2	49
MS9068-152	96906	B-2	6	57817	35510	B-2	31
MS9068-156	96906	B-2	18	73503	35510	B-2	19
MS90725-6	96906	B-2	38	73512	35510	B-2	35
SO54071063	35510	B-2	N.I.	73515	35510	B-2	11
Z082071044	35510	B-2	9	73516	35510	B-2	12
Z082071046	35510	B-2	29	73517	35510	B-2	10
Z083021293	35510	B-2	2	73524	35510	B-2	13
Z093001613	35510	B-2	37	73566	35510	B-2	1
Z095071042	35510	B-2	27	73575	35510	B-2	33
Z095071045	35510	B-2	7	8738047	19207	B-2	28
Z096071059	35510	B-2	3	8738050	19207	B-2	20
Z096071060	35510	B-2	17	8738057	19207	B-2	16
Z098073450	35510	B-2	23	8738058	19207	B-2	41



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By Order of the Secretary of the Army:

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To be distributed in accordance with DA Form 12-38, Direct and General Support maintenance requirements for 2½ Ton Truck Cargo 6x6, 5 Ton Truck Chassis 6x6 and 5 Ton Truck Cargo 8x8.





