

# TM 9-2920-242-35

## DEPARTMENT OF THE ARMY TECHNICAL MANUAL

---

DIRECT SUPPORT, GENERAL SUPPORT, AND DEPOT  
MAINTENANCE  
(INCLUDING REPAIR PARTS)

STARTER, ENGINE ELECTRICAL, ASSEMBLY

2920-00-226-6545

(DELCO-REMY MODEL 1113943)

(MILITARY PART NUMBER 10911018-1)

STARTER, ENGINE ELECTRICAL ASSEMBLY

2920-00-911-5637

(DELCO-REMY MODEL 1113904)

(MILITARY PART NUMBER 10911018)

STARTER, ENGINE ELECTRICAL ASSEMBLY

2920-00-912-9510

(DELCO-REMY MODEL 1113944)

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**DIRECT SUPPORT, GENERAL SUPPORT  
AND DEPOT MAINTENANCE  
(INCLUDING REPAIR PARTS)**

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2920-00-226-6545  
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STARTER, ENGINE, ELECTRICAL, ASSEMBLY  
2920-00-912-9510  
(DELCO-REMY MODEL 1113944)**

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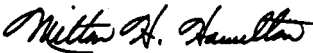
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**Direct Support, General Support, and  
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**Direct Support, General Support, and Depot Maintenance Manual  
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**STARTER, ENGINE ELECTRICAL, ASSEMBLY — 2920-226-6545  
(DELCO-REMY MODEL 1113943)**

**(MILITARY PART NUMBER 10911018-1)**

**STARTER, ENGINE ELECTRICAL, ASSEMBLY — 2920-911-5637  
(DELCO-REMY MODEL 1113904)**

**(MILITARY PART NUMBER 10911018)**

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(DELCO-REMY MODEL 1113944)**

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**DS, GS, and Depot Maintenance Manual  
(Including Repair Parts)**

**STARTER, ENGINE ELECTRICAL, ASSEMBLY-2920-226-6545  
(DELCO-REMY MODEL 1113943)  
(MILITARY PART NUMBER 10911018-1)**

**STARTER, ENGINE ELECTRICAL, ASSEMBLY-2920-911-5637  
(DELCO-REMY MODEL 1113904)  
(MILITARY PART NUMBER 10911018)**

**STARTER, ENGINE ELECTRICAL, ASSEMBLY-2920-912-9510  
(DELCO-REMY MODEL 1113944)**

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**(Including Repair Parts)**

**STARTER, ENGINE ELECTRICAL, ASSEMBLY—2920-226-6545**  
**(DELCO-REMY MODEL 1113943)**  
**(MILITARY PART NUMBER 10911018-1)**

**STARTER, ENGINE ELECTRICAL, ASSEMBLY—2920-911-5637**  
**(DELCO-REMY MODEL 1113904)**  
**(MILITARY PART NUMBER 10911018)**

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**(DELCO-REMY MODEL 1113944)**

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| Front Cover | Add the following end item application:<br>Engine, Diesel, Multifuel, Turbocharged, 6-Cylinder (Military Model LDS-465-1A)<br>Engine, Diesel, Multifuel, 6-Cylinder (Military Model LD-465-1)<br>Engine, Assembly w/Accessories Mack Diesel Model ENDT-673<br>Engine, Diesel w/Accessories Cummins Model V8-300<br>Renumber alphabetical index pages (now 61, 62, and 63): I-1, I-2, and I-3 |

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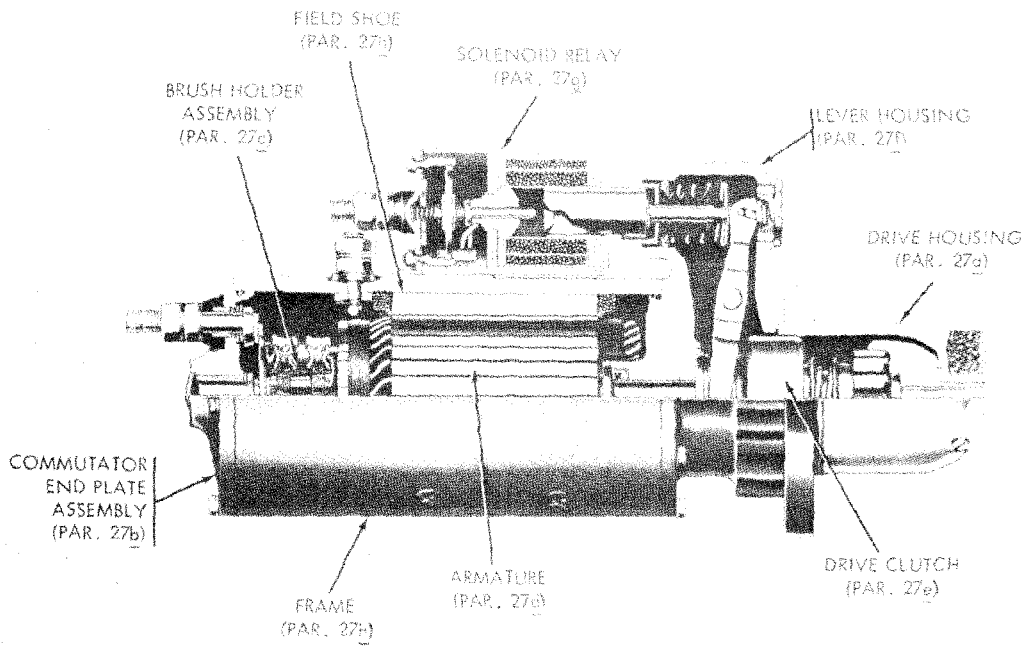
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**STARTER, ENGINE ELECTRICAL,  
 ASSEMBLY - 2920-226-6545  
 (DELCO-REMY MODEL 1113904)**

END ITEM APPLICATION

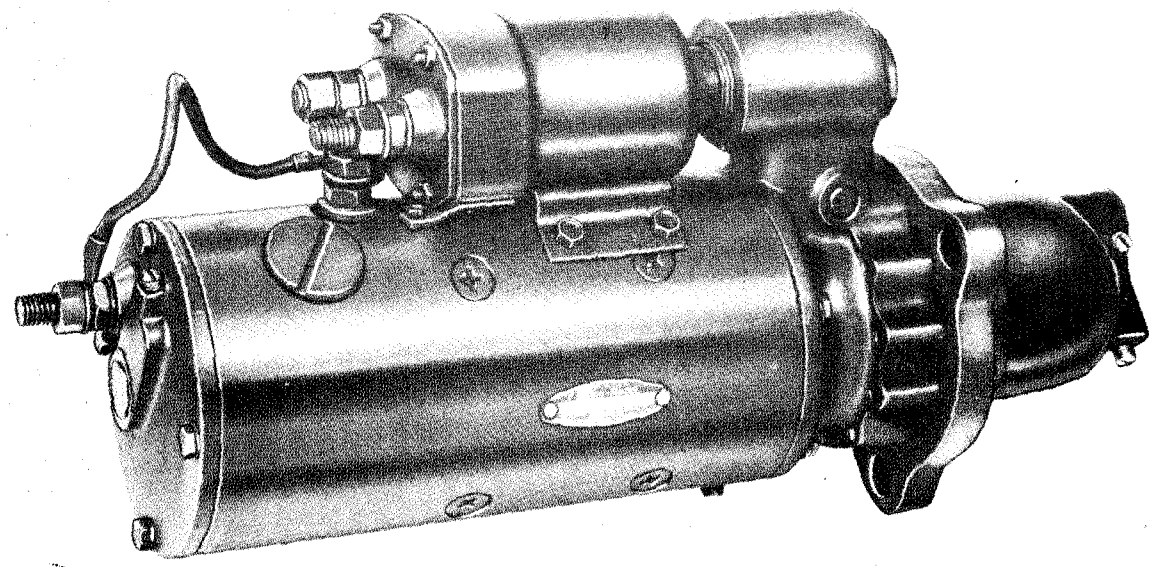
ENGINE, DIESEL, MULTIFUEL, 6-CYLINDER  
 (MILITARY MODEL LDS-465-1)

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FIGURE 1. STARTER ASSEMBLY - 2920-226-6545 - ASSEMBLED VIEW.

CHAPTER 1  
INTRODUCTION

---

Section I. GENERAL

1. SCOPE

a. This technical manual contains instructions for direct support, general support, and depot maintenance of the starter assembly, FSN 2920-226-6545 (fig. 1). It contains descriptions of, and procedures for, troubleshooting, disassembly, inspection, repair, and assembly of the starter.

b. Appendix I contains a list of current references applicable to the starter.

c. Appendix II contains an illustrated list of repair parts allocated to Direct and General Support and Depot Maintenance.

d. Any errors or omissions will be brought to the attention of the Commanding General,

U.S. Army Tank-Automotive Center, 28251 Van Dyke, Warren, Michigan, 48090, ATTN: SMOTA-MT, using DA Form 2028.

2. DIRECT SUPPORT, GENERAL SUPPORT, AND DEPOT MAINTENANCE ALLOCATION

Refer to maintenance allocation chart in pertinent vehicle organizational maintenance manual.

3. FORMS, RECORDS, AND REPORTS

For current and complete listing of all authorized forms, refer to current issue of DA Pamphlet 310-2. TM 38-750 contains instructions on use of forms for records and reports.

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Section II. DESCRIPTION AND DATA

4. DESCRIPTION

Note. The key letters shown in parentheses refer to figure 2.

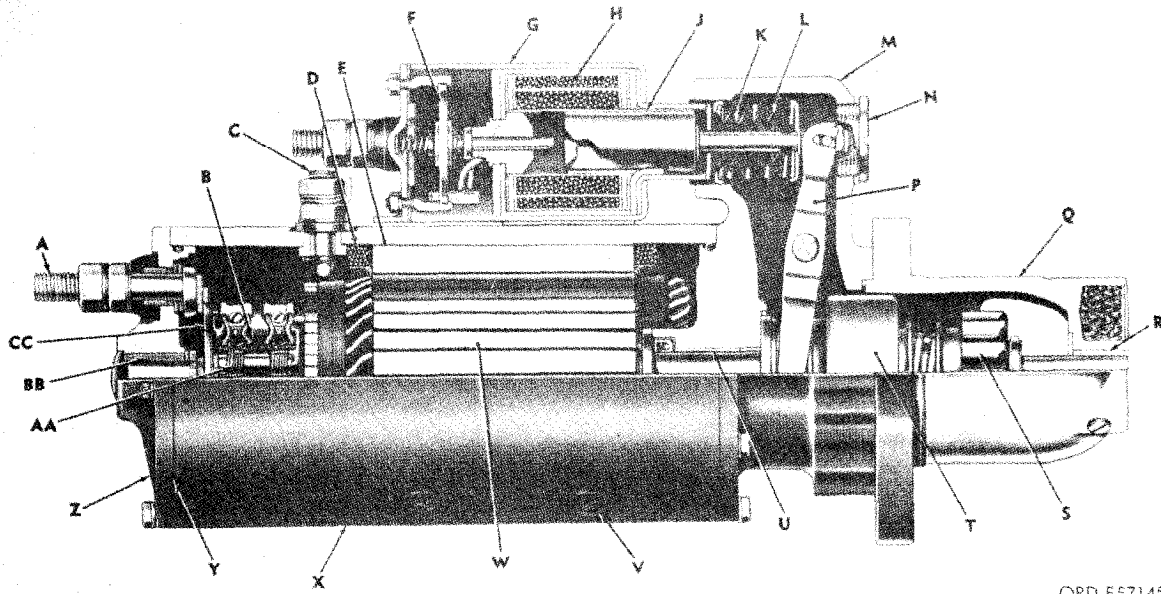
a. Description. This electrical starter is a heavy-duty, 24 volt, insulated, waterproof, fungus and corrosion resistant, solenoid-operated, enclosed shift-lever-type engine starter with eight brushes retained in four brush holders. The drive clutch is a heavy-duty overrunning type and the pinion clearance is adjustable. The principal components of the starter assembly are the frame assembly (X), armature (W), commutator end plate assembly (Z), brush holder assembly (CC), brushes (B), drive clutch assembly (T), drive housing (Q), solenoid relay assembly (G), lever housing (M), shift lever (P), and solenoid plunger (J).

(1) Frame assembly. The frame assembly (X) consists of the field coils (D), pole shoes (E), and field coil terminal stud (C), all supported by a heavy steel frame. The field coils are secured to

the frame by the pole shoes and eight pole shoe screws (V). The coils are connected to the field coil terminal stud which is insulated from the frame. The frame has screw thread openings for mounting the solenoid relay.

(2) Armature. The armature (W) is made of copper and laminated steel assembled on a steel shaft. It is supported by three sleeve bearings (R, U, and BB). The armature has straight splines on the drive end of the shaft which engage splines on the drive clutch assembly (T). A commutator, located at the brush end of the armature, is the electrical point of contact of the armature.

(3) Commutator end plate assembly. The commutator end plate assembly (Z) serves as an end closure for the frame and a bearing support for the armature. It also serves as a support for the brush holder assembly (CC). The brush holder assembly is a component part of the commutator end plate assembly.



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- |                                   |                                   |
|-----------------------------------|-----------------------------------|
| A - Brush holder terminal stud    | Q - Drive housing                 |
| B - Brush                         | R - Sleeve bearing                |
| C - Field coil terminal stud      | S - Drive pinion                  |
| D - Field coil                    | T - Drive clutch assembly         |
| E - Pole shoe                     | U - Sleeve bearing                |
| F - Contact assembly              | V - Pole shoe screw               |
| G - Solenoid relay assembly       | W - Armature                      |
| H - Solenoid relay coil           | X - Frame assembly                |
| J - Solenoid plunger              | Y - End plate gasket              |
| K - Rubber bellows                | Z - Commutator end plate assembly |
| L - Plunger spring                | AA - Brush spring                 |
| M - Lever housing                 | BB - Sleeve bearing               |
| N - Lever housing inspection plug | CC - Brush holder assembly        |
| P - Shift lever                   |                                   |

FIGURE 2. STARTER ASSEMBLY - SECTIONAL VIEW

- (4) Brushes and brush holder assembly. The eight brushes (B), which function as the electrical contact to the commutator, are supported by four brush holders and are held in contact with the commutator by eight helical torsion brush springs (AA). Two pairs of brushes are connected to a brush holder terminal stud (A) which extends through the commutator end plate. Each of the remaining two pairs is connected to a field coil.
- (5) Drive housing. The drive housing (Q) serves as a bearing support for the drive end of the armature shaft, and as a housing for the drive pinion (S). It also is the attaching support for the starter. Three holes are provided for attachment to the engine.
- (6) Lever housing. The lever housing (M) serves as the armature center bearing support, as an end plate for the motor portion of the starter, and as a housing

for the drive clutch assembly (T) and shift lever (P).

- (7) Drive clutch assembly. The drive clutch assembly (T) is an overrunning clutch-type drive consisting primarily of a shell, clutch sprags, spring, sleeve, and drive pinion. The shell has internal splines which mesh with those of the armature shaft and external flanges which serve as contact surfaces for the shift lever. It also serves as a housing and outer contact surface for the sprags. The sleeve supports the drive pinion and the sprags. The spring-loaded drive pinion has 12 external teeth, with another tooth blank, and internal helical splines which match with splines on the sleeve. Thirty sprags, held together by a sprag (garter) spring are positioned around the end of the sleeve inside the shell. These sprags are small billets of steel with the upper and lower surfaces rounded so the diagonals across the sprag are of unequal length. The ends of the sprags are slotted at an angle for the sprag spring causing the sprags to position around the sleeve at any angle, in the locked position.
- (8) Solenoid relay assembly. The solenoid relay assembly (G) consists of a case which encloses the solenoid relay coil (H), a contact assembly (F), and a terminal plate assembly.
- (9) Solenoid plunger and shift lever. A spring loaded cylindrical solenoid plunger (J) is installed in the bore of the solenoid relay to provide the necessary shifting action when the solenoid is actuated. The spring returns the plunger to the disengaged position whenever the relay is not engaged. The shift lever (P) is connected between the solenoid plunger and the drive clutch and is pivoted at the center. A rubber bellows (K) is provided to cover the plunger spring (L) and seal the end of the solenoid relay.

#### b. Operation.

- (1) The solenoid relay makes possible the control of the starter from an outside source and permits operation-h full battery voltage. When the switch circuit to the solenoid relay is closed, the sole-

noid coil is energized, producing a magnetic field in the solenoid. The magnetic field causes a pull to be exerted on the solenoid plunger, moving the plunger into the solenoid.

- (2) As the plunger moves into the solenoid case, it exerts a pull on the shift lever which shifts the drive clutch pinion into mesh with the ring gear on the engine flywheel.
- (3) After the plunger has moved the distance necessary to engage the pinion with the engine flywheel ring gear, the end of the plunger presses against the shaft of the solenoid relay contact assembly. This movement causes the contact disk of the contact assembly to close the circuit across the battery and motor terminals of the solenoid relay.
- (4) When the circuit is closed electrical current flows to the starter, forming magnetic fields about the field coils and the armature. The interaction of the magnetic fields causes the armature to start to rotate.
- (5) The armature torque is transferred to the engine through the drive clutch. When the clutch sprags are rotated so the larger diagonal approaches a radial position, a wedging action occurs, locking the inner race on the sleeve to the outer race in the shell. The sprag (garter) spring, placed around the sprags, holds the sprags in the locked position so torque can be transmitted without delay when the armature starts rotating. When the engine starts and exceeds the speed of the armature, the sprags slip between the sleeve and shell, protecting the starter.
- (6) When the outside control circuit to the solenoid relay is broken, the solenoid circuit is broken. The solenoid plunger is no longer held by the solenoid and it is returned to its original position by spring pressure. This breaks the circuit to the starter as the contact disk in the solenoid is moved away from the battery and motor terminals. At the same time the shift lever pulls the drive clutch back to its original position and the pinion is disengaged from the engine flywheel ring gear.



5. DATA

|   |                                   |
|---|-----------------------------------|
| Voltage   | 24 v dc                           |
| Torque (lock min)   | 26 lb-ft (at 500 amps, 3.5 volts) |
| Pinion speed (no load)  | 7000-10700 rpm                    |
| Pinion rotation (facing drive-end)                            | clockwise                         |
| Number of teeth on clutch assembly (pinion) (one tooth blank) | .12                               |
| Mounting data:  |                                   |
| Number of mounting holes...                                   | 3                                 |
| Diameter of mounting holes                                    | 0.6592 in.                        |
| Mounting hole circle diameter.                                | 5.75 in.                          |
| Length  | 19.96 ± 0.12 in.                  |
| Diameter (field frame)  | 5.56 ± 0.04 in.                   |
| Weight (approx)   | 65 lbs                            |

## CHAPTER 2

### PARTS, SPECIAL TOOLS, AND EQUIPMENT FOR DIRECT AND GENERAL SUPPORT AND DEPOT MAINTENANCE

#### 6. GENERAL

Tools, equipment, and maintenance parts over and above those available to the using organization are supplied to direct support, general support, and depot maintenance units for maintaining and repairing the starter.

#### 7. PARTS

Maintenance parts are listed in Appendix II, Direct Support, General Support, and Depot Maintenance Repair Parts List, which is the authority for requisitioning replacement parts.

#### 8. COMMON TOOLS AND EQUIPMENT

Standard and commonly used tools and equipment having general application to this material are listed in DA supply manuals SM 9-4-4910-

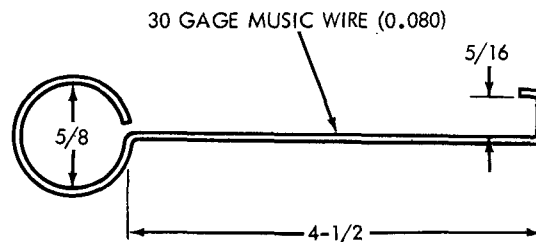
A02, A03, A38, A57, A73, A74, A75, A76, A78, A79, A80, A86, A87, and A88; SM 9-4-5180-A17, A82, and B14 and are authorized for issue by T/A and TOE.

#### 9. SPECIAL TOOLS AND EQUIPMENT

There are no special tools or equipment required to perform the repair operations contained in this manual.

#### 10. IMPROVISED TOOLS

A dimensional detail drawing of an improvised brush spring lifter is shown in figure 3. It applies only to direct and general support maintenance shops in order to enable these maintenance shops to fabricate the tool locally, if desired. It is not essential for maintenance and is not available for issue.



NOTE. ALL DIMENSIONS SHOWN ARE IN INCHES

ORD E16887

FIGURE 3. IMPROVISED BRUSH SPRING  
LIFTER

CHAPTER 3  
TROUBLESHOOTING

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Section I. GENERAL

11. PURPOSE

Note. Information in this chapter is for use of maintenance personnel in conjunction with, and as a supplement to, the troubleshooting section in the pertinent vehicle organizational maintenance manual. It provides continuation of instructions where a remedy in the organizational maintenance manual refers to technical maintenance personnel for corrective action.

Operation of a deadlined vehicle without a preliminary examination can cause further damage to a disabled starter and possible injury to personnel. By careful inspection and troubleshooting, such damage and injury can be avoided and, in addition, the causes of faulty operation of the starter can often be determined without extensive disassembly.

12. GENERAL INSTRUCTIONS AND PROCEDURES

This chapter contains inspection and trouble-

shooting procedures to be performed after a starter has been removed from the engine.

a. Inspection after the starter is removed from the engine is performed to verify any diagnosis made when the starter was on the engine, to uncover further defects, or to determine malfunctions if the starter alone is received by the maintenance establishment. This inspection is particularly important in the last case because it is often the only method of determining the malfunction without completely disassembling the starter.

b. Troubleshooting a disabled starter after it has been removed from the engine consists of subjecting it to tests on a suitable test stand. This chapter discusses those symptoms which can be diagnosed by using the testing equipment and interprets the results in terms of probable causes. Information pertaining to this testing is contained in paragraphs 37 through 39.

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Section II. TROUBLESHOOTING PROCEDURES

13. GENERAL

The major troubleshooting procedures performed on a starter after removal from an engine are made on a test stand. However, the starter should be inspected before the tests are performed to eliminate the possibility of further damage. Rotate the armature by hand to make sure it is free. If difficulty is encountered, disassemble the started (pars. 18 through 23). If the armature turns freely, continue with troubleshooting procedures. When the cause for failure has been determined, the starter should be dis-

assembled and repaired before proceeding with further tests. Additional operational tests performed on a damaged starter would only increase the damage.

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

14. TROUBLESHOOTING TABLE

Table I lists the common malfunctions that might be encountered, their probable cause, and the recommended corrective action.

Table I. Troubleshooting

| Malfunction   | Probable causes  | Corrective action   |
|---|--|---|
| <p>1. Starter fails to operate or turns slowly.</p> | <p><u>a.</u> Starter frozen.</p> <p><u>b.</u> Defective solenoid relay.</p> <p><u>c.</u> Worn brushes or defective springs.</p> <p><u>d.</u> Worn or pitted commutator.</p> <p><u>e.</u> Eccentric commutator.</p> <p><u>f.</u> Shorted or grounded commutator.</p> <p><u>g.</u> Grounded field coils.</p> | <p><u>a.</u> Disassemble starter (par. 18) and check for cause.</p> <p><u>b.</u> Check for operation of solenoid by placing a jumper across battery terminal and solenoid switch terminal. If solenoid does not operate, replace solenoid relay (pars. 18 and 35).</p> <p><u>c.</u> Remove commutator end plate (par. 18c) and inspect brushes. Check brush spring tension (fig. 10). Install new brush kit if parts are defective (par. 35c).</p> <p><u>d.</u> Remove commutator end plate (par. 18c) and inspect commutator. Resurface commutator (par. 27d) or replace armature (par. 35c) if it cannot be reconditioned.</p> <p><u>e.</u> Remove armature (par. 18c) and check runout (fig. 22). Resurface commutator (par. 27d) or replace armature (par. 35c).</p> <p><u>f.</u> Remove commutator end plate (par. 18c) and check for evidence of excessive arcing. If arcing is evident, remove armature and check for grounds (fig. 20) or shorts (fig. 21). Replace armature, if defective (par. 35c).</p> <p><u>g.</u> Inspect field coils (par. 26i). Replace coils if defective (par. 30).</p> |

Table I. Troubleshooting - Continued

| Malfunction  | Probable causes   | Corrective action  |
|--|---|--|
| 2. Low speed and low current.                      | <p><u>a.</u> High internal resistance.</p> <p><u>b.</u> Poor brush contact.</p>   | <p><u>a.</u> Remove commutator end plate (par. <u>18c</u>) and tighten brush leads.</p> <p><u>b.</u> Remove commutator end plate (par. <u>18c</u>) and inspect brushes and commutator. Install new brush kit (par. <u>35c</u>) and re-seat new brushes or resurface commutator (par. 27d).</p>   |
| 3. Low speed and high current.                     | <p><u>a.</u> Faulty armature.</p> <p><u>b.</u> Armature drag.</p>   | <p><u>a.</u> Remove commutator end plate (par. <u>18c</u>) and inspect commutator for evidence of excessive arcing. If indicated, remove armature and check for grounds (fig. 20) or shorts (fig. 21). Replace armature, if defective (par. <u>35c</u>).</p> <p><u>b.</u> Disassemble starter (par. 18) and inspect bearings and armature (par. 26). Repair as required.</p> |
| 4. Starter produces excessive noise when operated. | <p><u>a.</u> Lack of lubrication.</p> <p><u>b.</u> Defective bearings.</p> <p><u>c.</u> Loose pole shoes.</p> <p><u>d.</u> Loose housing.</p> | <p><u>a.</u> Lubricate bearings (par. 29).</p> <p><u>b.</u> Disassemble starter (par. 18) and replace defective bearings.</p> <p><u>c.</u> Tighten pole shoe screws as shown in figure 18.</p> <p><u>d.</u> Tighten all housing attaching screws.</p>  |
| 5. Starter drive clutch fails to shift.            | <p><u>a.</u> Defective solenoid relay.</p>  | <p><u>a.</u> Check operation of solenoid by placing a jumper across battery terminal and solenoid switch terminal. If solenoid does not operate, replace solenoid relay (pars. <u>18e</u> and <u>35a</u>).</p>   |

Table I. Troubleshooting - Continued

| Malfunction                           | Probable causes   | Corrective action   |
|---------------------------------------|---|---|
| 5. Continued -----                    | <p><u>b.</u> Loose adjustment nut.</p> <p><u>c.</u> Binding in shift lever or drive clutch.</p> | <p><u>b.</u> Remove inspection plug (c, fig. 31, step 5) and check adjustment nut. If loose, adjust pinion clearance (par. 36).</p> <p><u>c.</u> Remove lever housing (par. 18) and check for defective lever or clutch. Replace defective parts as required (pars. 21, 34 and 35).</p> |
| 6. Pinion will not override.          | Defective drive clutch.   | Remove drive housing and replace drive clutch (pars. 18 and 35).  |
| 7. Starter vibrates during operation. | Worn or damaged bearings.   | Disassemble starter (par. 18) and replace defective bearings.   |
| 8. Excessive arcing of brushes.       | <u>a.</u> Worn, binding, or broken brushes or defective springs.                                | <u>a.</u> Remove commutator end plate (par. 18c) and inspect brushes. Check brush spring tension (fig. 10). Install new brush kit (par. 35c) if parts are defective and re-seat brushes.  |
|                                       | <u>b.</u> Scored, pitted, or dirty commutator.  | <u>b.</u> Remove commutator end plate (par. 18c) and inspect commutator. Clean commutator (par. 25c) or resurface commutator (par. 27d).  |
|                                       | <u>c.</u> Eccentric commutator.   | <u>c.</u> Remove armature (par. 18c) and check runout (fig. 22). Resurface commutator (par. 27d) or replace armature (par. 35c).  |
|                                       | <u>d.</u> Commutator mica not undercut properly.  | <u>d.</u> Remove armature (par. 18c) and inspect commutator. Under cut mica (par. 27c).   |
|                                       | <u>e.</u> Shorted or grounded field coils.  | <u>e.</u> Inspect field coils (par. 26i). Replace coils (par. 30).  |
|                                       | <u>f.</u> Shorted or grounded armature windings.  | <u>f.</u> Remove armature (par. 18c) and check for grounds (fig. 20) or shorts (fig. 21). Replace armature (par. 35c).  |

## CHAPTER 4

### REPAIR

#### Section I. GENERAL

##### 15. REMOVAL AND INSTALLATION

Refer to the appropriate maintenance manual for instructions covering the removal and installation of the starter.

##### 16. CLEANING BEFORE DISASSEMBLY

Before beginning disassembly operations, wash the starter exterior thoroughly with dry cleaning solvent or mineral spirits paint thinner and dry with compressed air.

#### Section II. DISASSEMBLY

##### 17. GENERAL

a. Disassemble of the starter should be performed in the sequence presented in the following paragraphs. Where reference is made to an illustration, follow the numbered steps in order specified. Judgement must be exercised in following the disassembly procedures to perform only the operations that are necessary.

b. Discard all preformed packings, gaskets, and oil seals during disassembly and replace them with new parts during assembly.

c. The exploded views in Appendix II may be

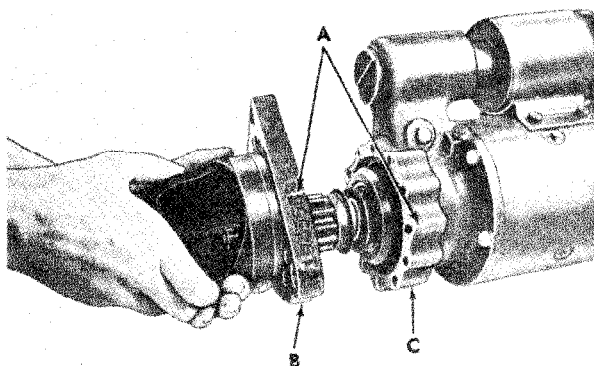
used as a guide to show relationship of parts and subassemblies.

##### 18. DISASSEMBLY INTO SUBASSEMBLIES

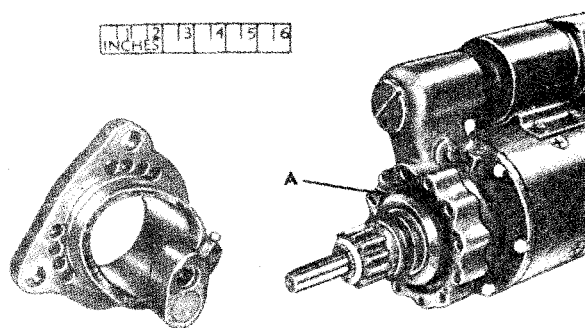
a. Refer to figure 4 and remove drive housing-assembly.

b. Refer to figure 5 and remove lead assembly and disconnect field coil brush connections.

Note. Tag all electrical contact brushes during removal to facilitate connection in respective positions during assembly if inspection indicates that they are in serviceable condition.



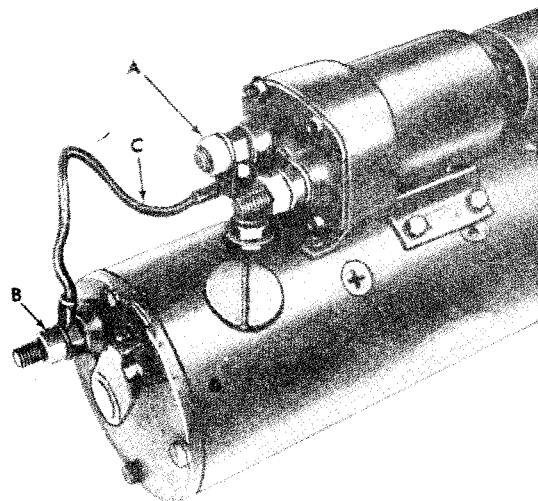
STEP 1. SCRIBE A MARK (A) ACROSS DRIVE HOUSING (B) AND LEVER HOUSING (C) TO LOCATE RELATIVE POSITIONS FOR ASSEMBLY. REMOVE SIX INTERNAL WRENCHING BOLTS AND PULL DRIVE HOUSING FROM STARTER. MARK LOCATION OF ONE SHORT BOLT FOR ASSEMBLY.



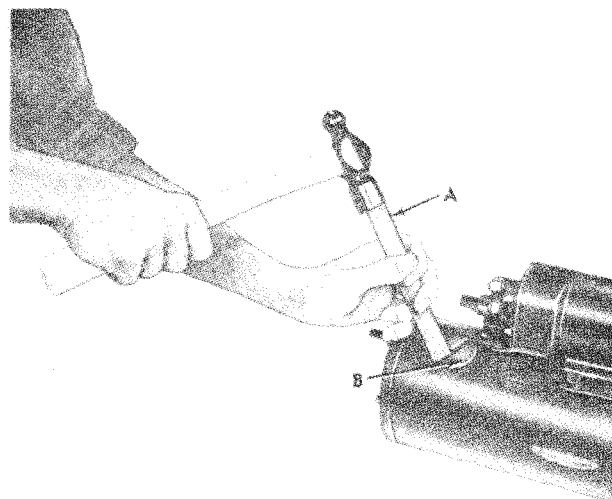
STEP 2. REMOVE GASKET (A) FROM LEVER HOUSING. DISCARD GASKET.

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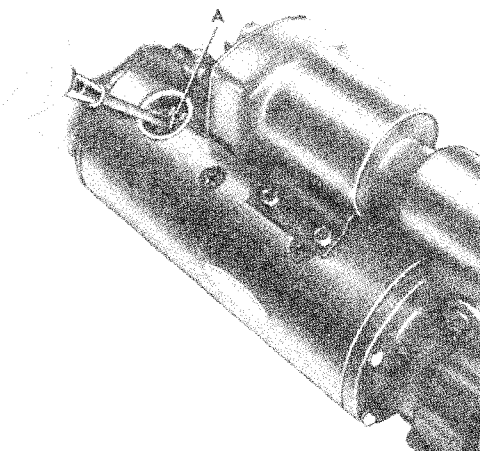
FIGURE 4. REMOVING DRIVE HOUSING ASSEMBLY.



STEP 1. LOOSEN TERMINAL SCREW (A) ON SOLENOID RELAY TERMINAL. REMOVE HEX NUT (B) AND LOCK WASHER AND REMOVE LEAD ASSEMBLY (C).



STEP 2. USING A SOFT BRASS BAR (A), LOOSEN TWO INSPECTION PLUGS (B). REMOVE PLUGS AND GASKETS. DISCARD GASKETS.



STEP 3. REMOVE BRUSH AND FIELD COIL CONNECTION ATTACHING SCREW (A) FROM EACH OF THE HOLES. MARK THE SCREW HOLES TO IDENTIFY THEM DURING FINAL ASSEMBLY OF BRUSHES.

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**FIGURE 5. REMOVING LEAD ASSEMBLY AND DISCONNECTING FIELD COIL BRUSH ASSEMBLY.**

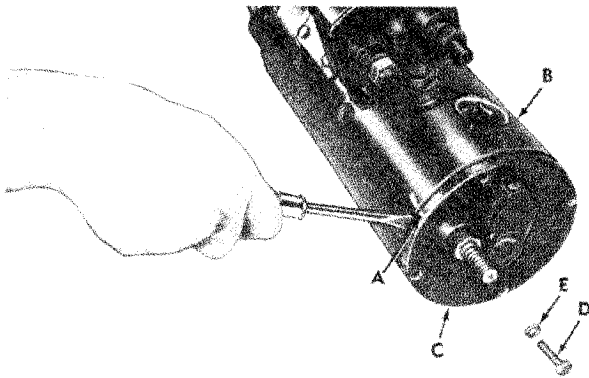


c. Refer to figure 6 and remove commutator end plate and brush holder assembly, and armature.

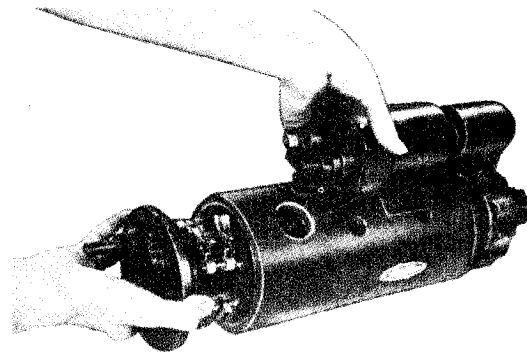
d. Refer to figure 7 and remove lever hous-

ing and drive clutch assembly.

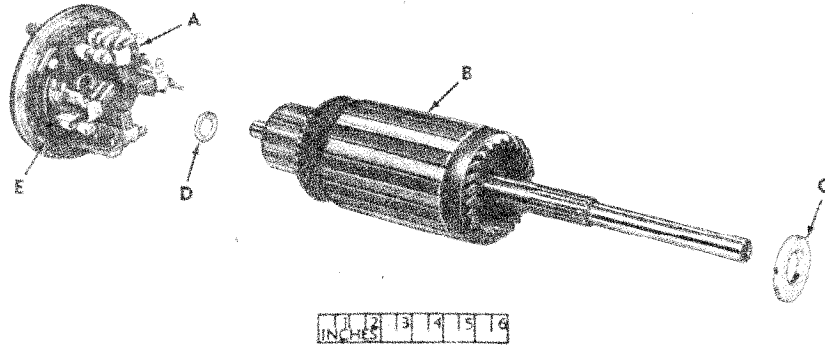
e. Refer to figure 8 and remove solenoid relay.



STEP 1. SCRIBE MARKS (A) ON FRAME (B) AND COMMUTATOR END PLATE (C). REMOVE FOUR HEX HEAD SCREWS (D) AND LOCK WASHERS (E) AND PRY END PLATE LOOSE FROM FRAME.



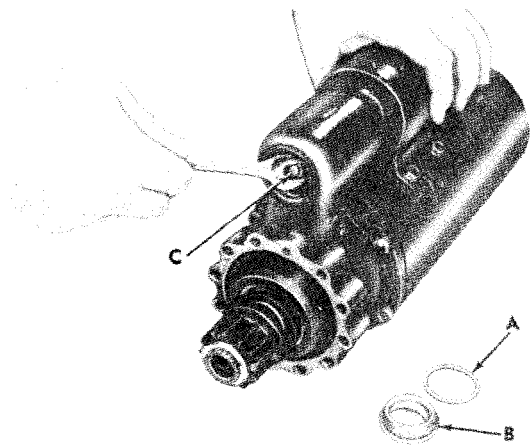
STEP 2. PULL COMMUTATOR END PLATE AND ARMATURE FROM FRAME.



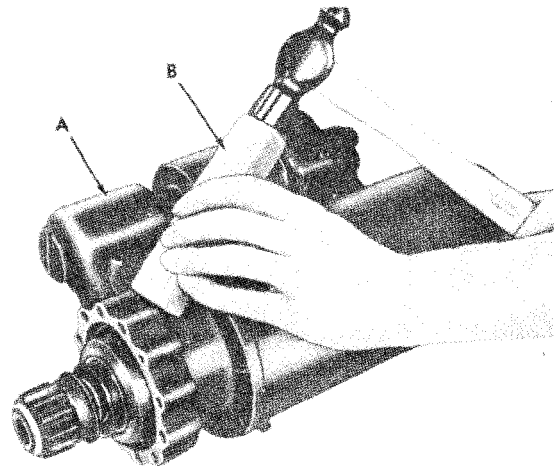
STEP 3. SEPARATE COMMUTATOR END PLATE AND BRUSHES (A) FROM ARMATURE (B). REMOVE SPACER (C), THRUST WASHER (D), AND PREFORMED PACKING (E). DISCARD PACKING.

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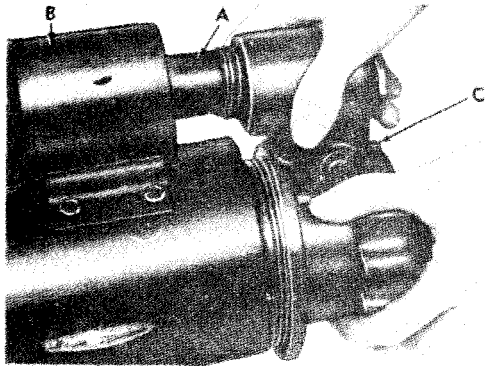
FIGURE 6. REMOVING COMMUTATOR END PLATE, BRUSHES, AND ARMATURE.



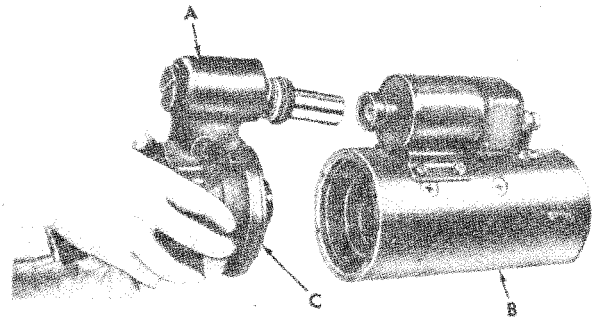
STEP 1. REMOVE INSPECTION PLUG (B) AND GASKET (A) FROM LEVER HOUSING. LOOSEN SELF-LOCKING NUT (C). INSTALL GASKET AND PLUG IN HOUSING TO PREVENT LOSS.



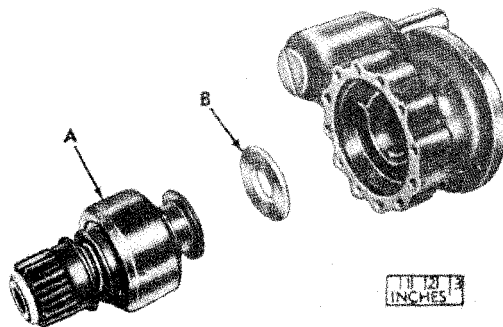
STEP 2. REMOVE FIVE HEX HEAD CAP SCREWS AND LOCK WASHERS SECURING LEVER HOUSING (A) TO FRAME. USING A BLOCK OF WOOD (B), TAP HOUSING UNTIL LOOSE.



STEP 3. WORK END OF RUBBER BELLOWS (A) FREE FROM SOLENOID RELAY (B) WHILE PULLING OUTWARD ON LEVER HOUSING (C).



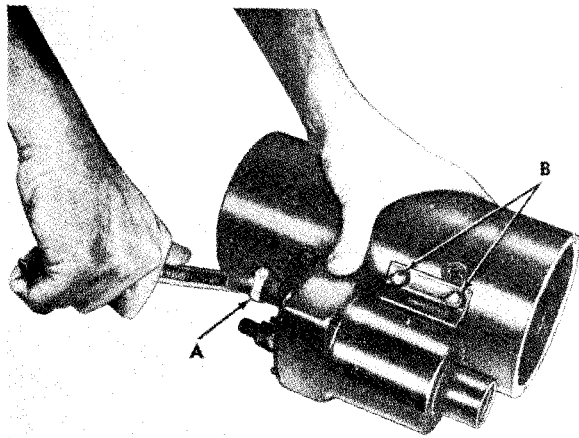
STEP 4. PULL LEVER HOUSING (A) AND ATTACHED PARTS FROM FRAME (B). REMOVE AND DISCARD PREFORMED PACKING (C).



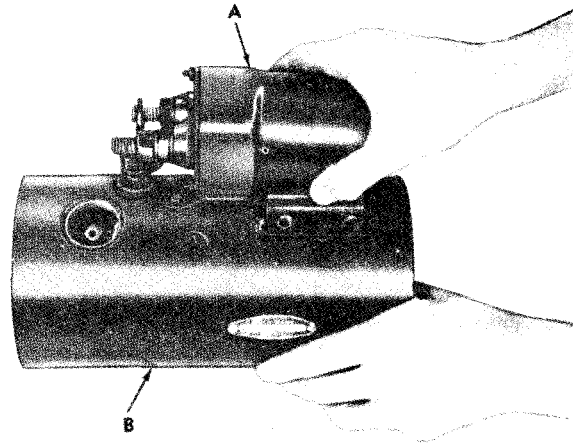
STEP 5. REMOVE DRIVE CLUTCH ASSEMBLY (A) AND NONMETALLIC WASHER (B) FROM LEVER HOUSING.

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FIGURE 7. SEPARATING LEVER HOUSING AND ATTACHED PARTS FROM FRAME.

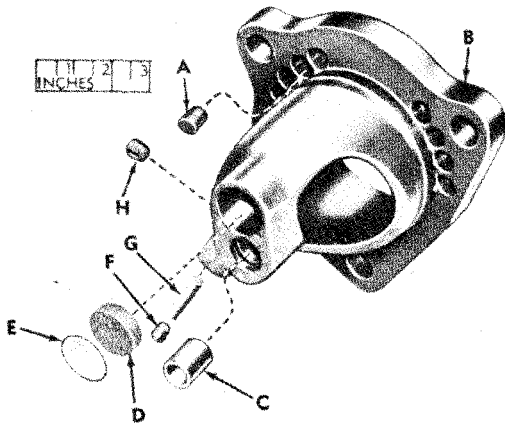


STEP 1. REMOVE HEX NUT (A) AND LOCK WASHER. REMOVE FOUR ASSEMBLED WASHER SCREWS (B).



STEP 2. SLIDE SOLENOID RELAY (A) FROM FRAME (B).  
ORD E57150

FIGURE 8. REMOVING SOLENOID RELAY.



PRESS OUT SLEEVE BEARING (C) ONLY IF BEARING IS LOOSE IN HOUSING (B) OR IF INSIDE DIAMETER DOES NOT CONFORM TO LIMITS SPECIFIED IN REPAIR STANDARDS (PAR. 41e). REMOVE PIPE PLUGS (H AND F), WICK (G), EXPANSION PLUG (E), FELT PLUG (D), AND RUBBER PLUGS (A).  
ORD E57151

FIGURE 9. DISASSEMBLING DRIVE HOUSING ASSEMBLY.

#### 19. DISASSEMBLY OF DRIVE HOUSING

a. The drive housing provides a bearing support for drive end of armature shaft and is attaching support for the starter.

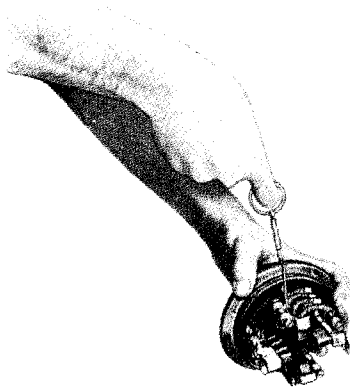
b. Refer to figure 9 and disassemble drive housing.

#### 20. DISASSEMBLY OF COMMUTATOR END PLATE ASSEMBLY

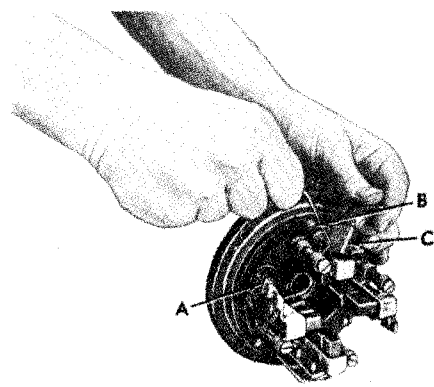
a. The commutator end plate serves as an end closure for the frame and as a bearing support for the armature. It also supports the brush holder assembly.

b. Refer to figure 10 and disassemble the commutator end plate assembly.

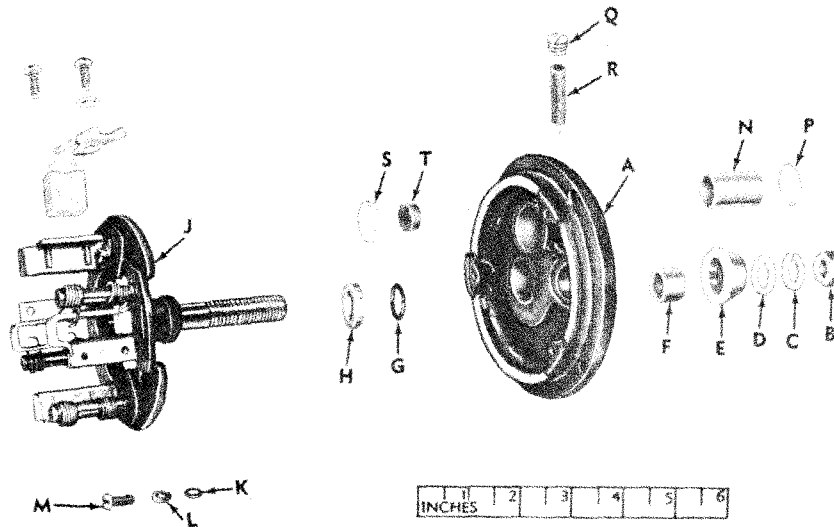
c. Refer to figure 11 and disassemble and brush holder assembly.



STEP 1. TEST BRUSH SPRING TENSION. TENSION MUST BE WITHIN LIMITS SPECIFIED IN REPAIR STANDARDS (PAR. 41a), REPLACE ENTIRE SET OF SPRINGS IF ANY ARE NOT WITHIN LIMITS SPECIFIED.



STEP 2. REMOVE SIX 5/16 INCH LONG AND TWO 3/8 INCH LONG PAN HEAD SCREWS (A) AND LOCK WASHERS. NOTE LOCATION FOR REASSEMBLY. LIFT BRUSH SPRING WITH BRUSH SPRING LIFTER (B) (SEE FIGURE 3) AND REMOVE BRUSH (C). REPEAT UNTIL EIGHT BRUSHES ARE REMOVED. MARK LOCATION OF BRUSHES BEFORE REMOVAL.

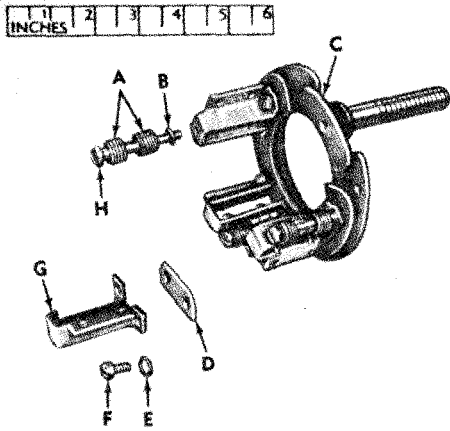


STEP 3. REMOVE HEX NUT (B), LOCK WASHER (C), AND FLAT WASHER (D), FROM TERMINAL STUD. REMOVE THREE PAN HEAD SCREWS (M), LOCK WASHERS (L), AND FLAT WASHERS (K), AND SEPARATE BRUSH HOLDER ASSEMBLY (J) FROM COMMUTATOR END PLATE (A). REMOVE PACKING (G) AND WASHER (H) FROM TERMINAL STUD. REMOVE BUSHING (F) AND TERMINAL STUD INSULATOR (E) FROM COMMUTATOR END PLATE.

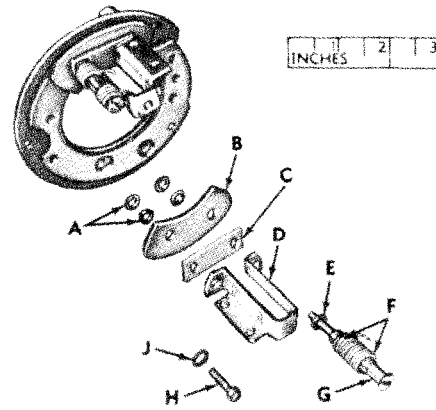
STEP 4. PRESS OUT SLEEVE BEARING (N) AND EXPANSION PLUG (P) ONLY IF BEARING IS LOOSE IN END PLATE (A) OR IF INSIDE DIAMETER DOES NOT CONFORM TO LIMITS SPECIFIED IN REPAIR STANDARDS (PAR. 41e). REMOVE PIPE PLUG (Q), WICK (R), EXPANSION PLUG (S), AND FELT PLUG (T).

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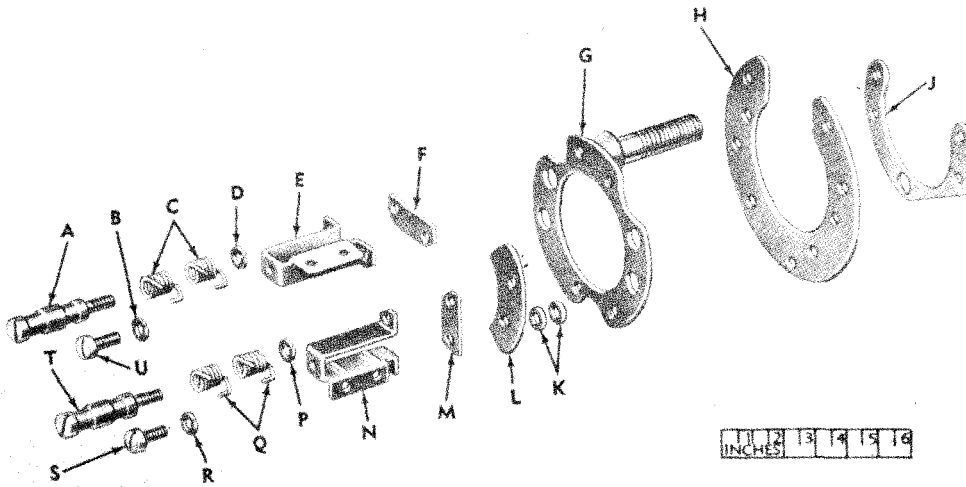
FIGURE 10. DISASSEMBLING COMMUTATOR END PLATE ASSEMBLY.



STEP 1. REMOVE TWO GROUNDED BRUSH HOLDER SCREWS (H), TWO FILLISTER HEAD SCREWS (F), FOUR LOCK WASHERS (E), TWO GROUNDED BRUSH HOLDERS (G), AND TWO SPACER PLATES (D). SLIDE LOCK WASHER (B) AND TWO BRUSH SPRINGS (A) FROM EACH BRUSH HOLDER SCREW.



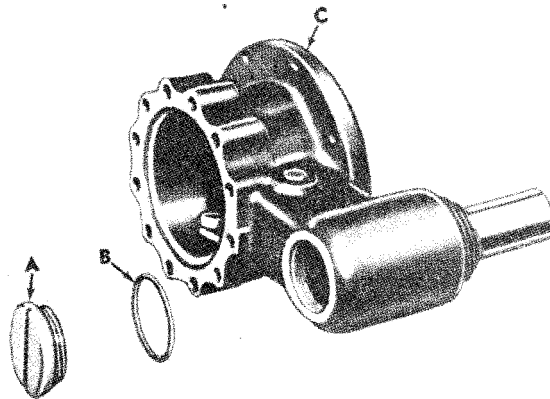
STEP 2. REMOVE TWO INSULATED BRUSH HOLDER SCREWS (G), TWO FILLISTER HEAD SCREWS (H), FOUR LOCK WASHERS (J), TWO INSULATED BRUSH HOLDERS (D), SPACER PLATE (C), AND BRUSH HOLDER PLATE INSULATION (B). SLIDE LOCK WASHER (E) AND TWO BRUSH SPRINGS (F) FROM EACH BRUSH HOLDER SCREW. REMOVE NON-METALLIC WASHERS (A).



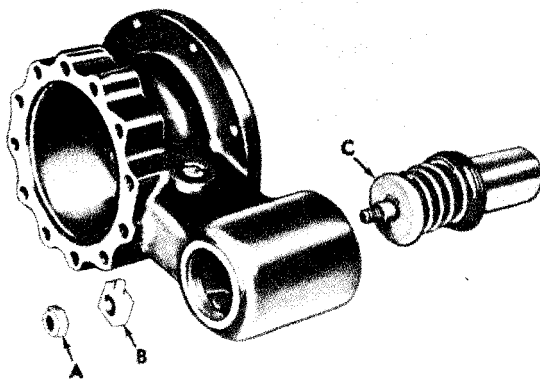
STEP 3. SEPARATE INSULATED BRUSH CONNECTION PLATE (J), AND BRUSH PLATE INSULATION (H) FROM TERMINAL PLATE (G).

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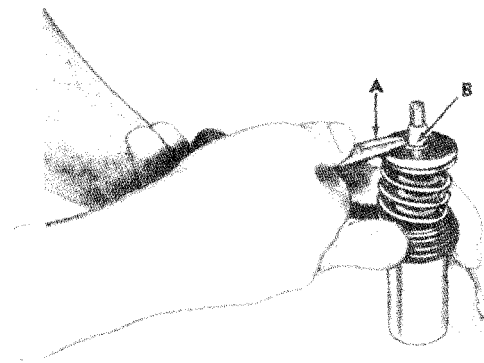
FIGURE 11. DISASSEMBLING BRUSH HOLDER ASSEMBLY.



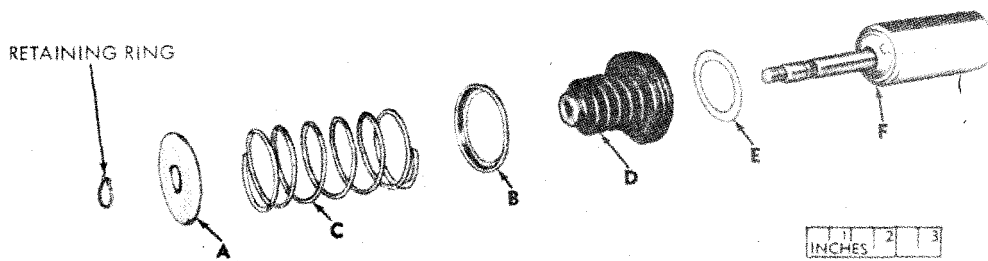
STEP 1. REMOVE INSPECTION PLUG (A) AND GASKET (B) FROM LEVER HOUSING (C). DISCARD GASKET.



STEP 2. REMOVE HEX SELF-LOCKING NUT (A), GUIDE (B), AND ASSEMBLED PLUNGER, SPRING, AND RUBBER BELLOWS (C).



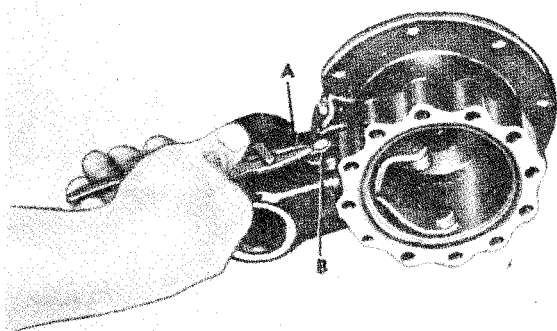
STEP 3. USING RETAINING RING PLIERS (A), REMOVE RETAINING RING (B) FROM PLUNGER SHAFT.



STEP 4. SEPARATE SPRING RETAINERS (A AND B), SPRING (C), RUBBER BELLOWS (D), WASHER (E), AND SOLENOID PLUNGER (F).

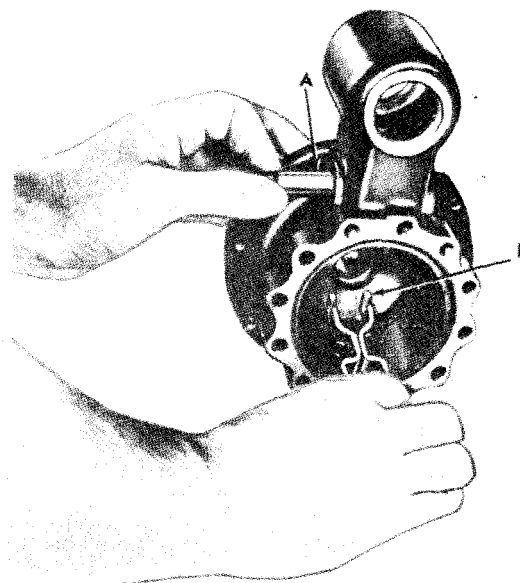
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FIGURE 12. REMOVING SOLENOID PLUNGER.



STEP 1. REMOVE RETAINING RING (B) USING RETAINING RING PLIERS (A).

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STEP 2. PULL LEVER SHAFT (A) FROM OPPOSITE SIDE OF HOUSING AND REMOVE SHIFT LEVER (B). REMOVE AND DISCARD TWO PREFORMED PACKINGS FROM SHAFT.

FIGURE 13. REMOVING SHIFT LEVER AND SHAFT.

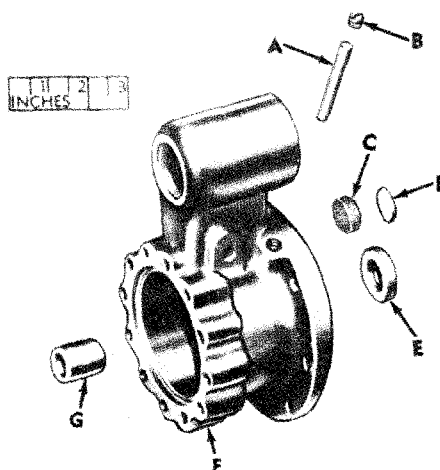
## 21. DISASSEMBLY OF LEVER HOUSING AND DRIVE CLUTCH ASSEMBLY

### a. Disassembly of Lever Housing.

- (1) The lever housing serves as the armature center bearing support, as an end plate for the motor portion of the starter, and as a housing for the drive clutch and shift lever.
- (2) Refer to figures 12, 13, and 14 and disassemble the lever housing.

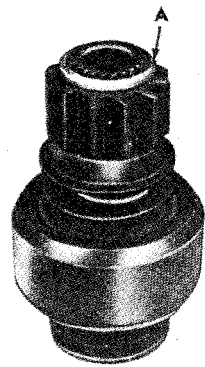
### b. Disassembly of Drive Clutch Assembly.

- (1) The drive clutch assembly transmits the torque developed by the armature to the engine flywheel ring gear.
- (2) Disassemble the drive clutch assembly as shown in figures 15 and 16.

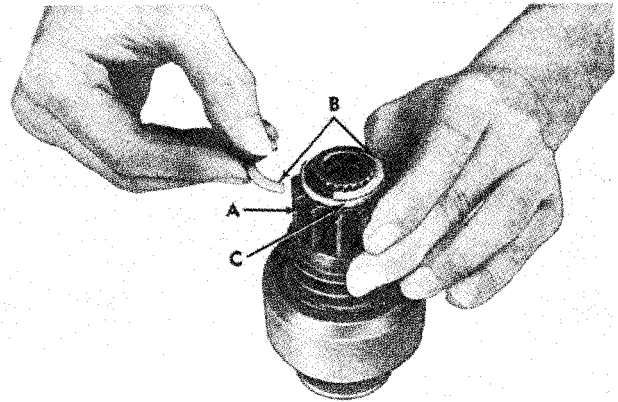


REMOVE OIL SEAL (E) AND DISCARD. REMOVE PIPE PLUG (B), WICK (A), EXPANSION PLUG (D), AND FELT PLUG (C). PRESS OUT SLEEVE BEARING (G) IF IT IS LOOSE IN LEVER HOUSING (F) OR IF INSIDE DIAMETER DOES NOT CONFORM TO LIMITS SPECIFIED IN REPAIR STANDARDS (PAR. 41e). ORD E57156

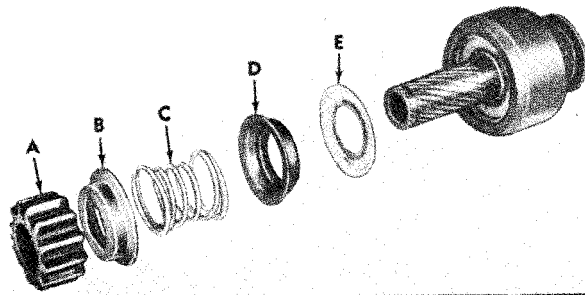
FIGURE 14. DISASSEMBLING LEVER HOUSING



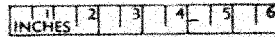
STEP 1. STRAIGHTEN ROLLED EDGE OF CUP (A).



STEP 2. PRESS PINION (A) DOWN AGAINST SPRING. REMOVE SPLIT WASHERS (B) AND WASHER CUP (C).



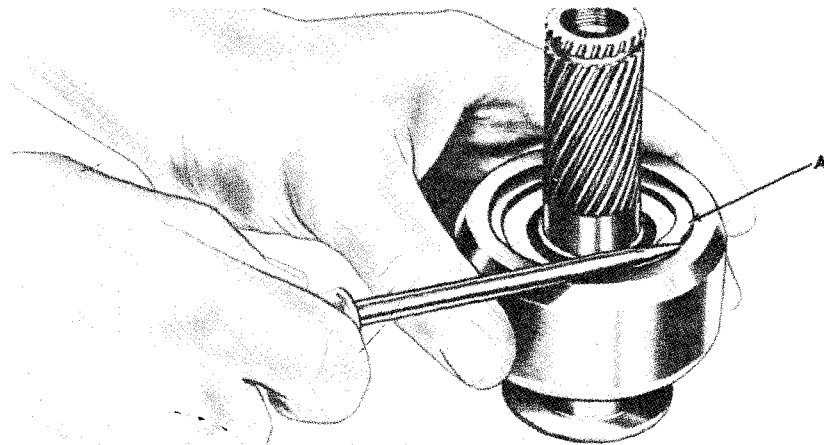
STEP 3. REMOVE DRIVE PINION (A), SPRING CUP (B), SPRING (C), SPRING CUP (D), AND BAFFLE (E).



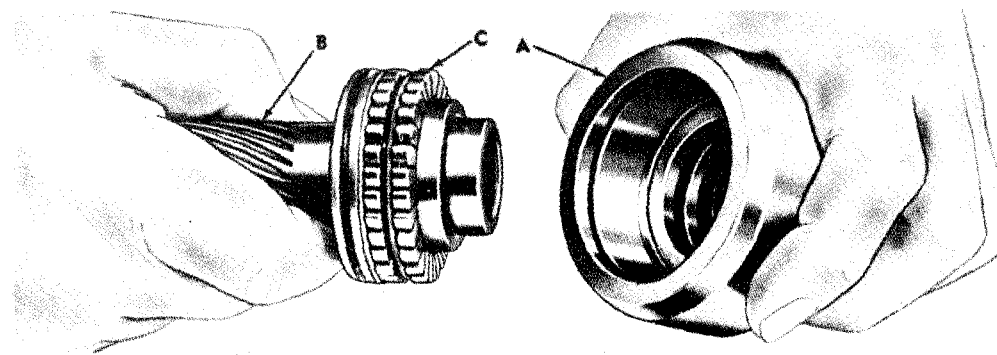
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FIGURE 15. DISASSEMBLING EXTERNAL PARTS OF DRIVE CLUTCH ASSEMBLY.

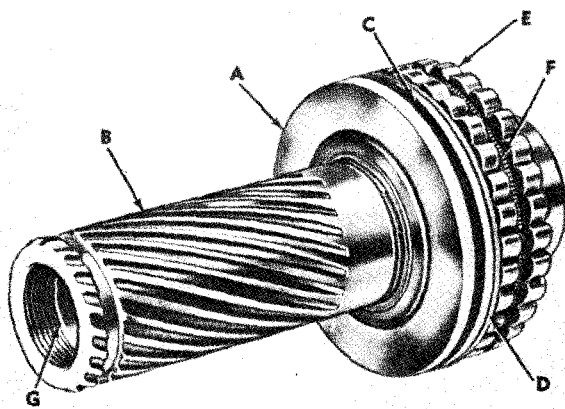




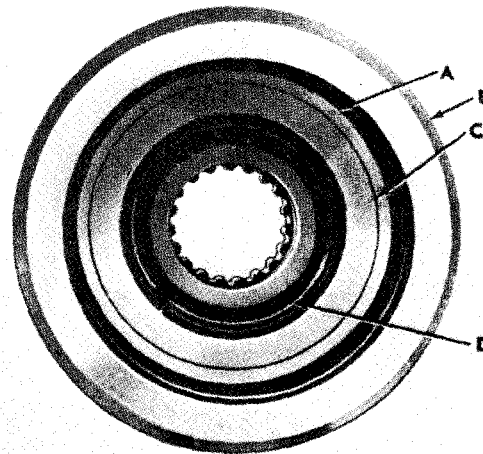
STEP 1. PRY OUT RETAINING RING (A) WITH A SCREW-DRIVER.



STEP 2. HOLD SHELL (A) AND TURN SLEEVE (B) CLOCKWISE TO UNLOCK SPRAGS (C). WHILE PULLING OUTWARD ON SLEEVE, TAP EDGE OF SHELL WITH A SOFT HAMMER IF NECESSARY. SEPARATE SLEEVE FROM SHELL.



STEP 3. SLIDE BEARING (A) FROM SLEEVE (B) AND REMOVE PREFORMED PACKING (C). REMOVE THRUST WASHER (D). REMOVE SPRAGS (E) AND SPRAG (GARTER) SPRING (F) AS A UNIT. PRESS OUT BEARINGS (G). DISCARD PACKING (C).



STEP 4. REMOVE THRUST WASHER (A) FROM SHELL (B). REMOVE BEARING (C) AND SEALING WASHER (D).

ORD E57158

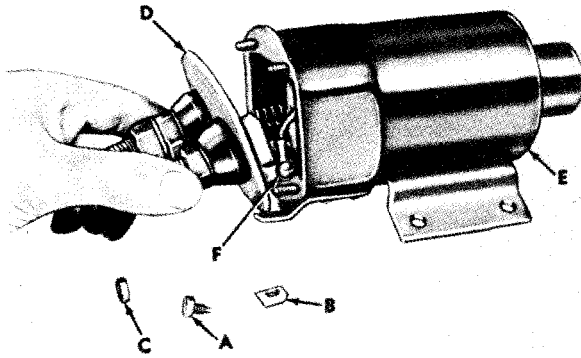
FIGURE 16. DISASSEMBLING INTERNAL PARTS OF DRIVE CLUTCH ASSEMBLY.

## 22. DISASSEMBLY OF SOLENOID RELAY

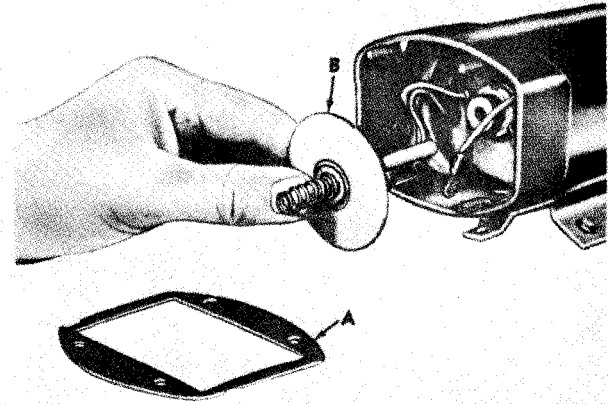
a. The solenoid relay shifts the starter drive pinion into mesh with the engine flywheel ring

gear and closes the electric circuit to the starting motor.

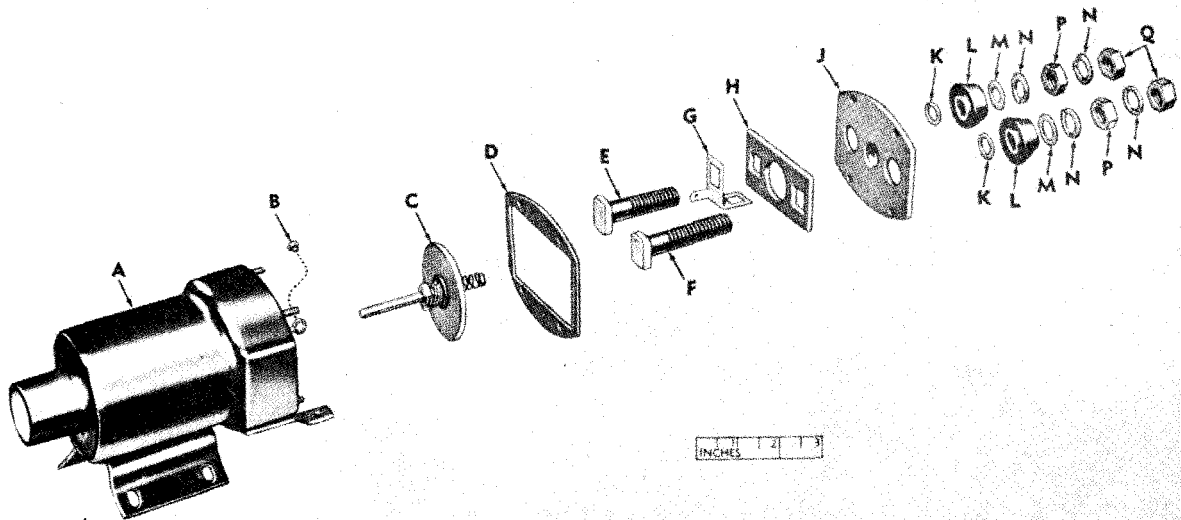
b. Disassemble the solenoid relay as shown in figure 17.



STEP 1. REMOVE TWO TERMINAL SCREWS (A) AND CLIPS (B). REMOVE FOUR EXTENDED WASHER NUTS (C), PULL TERMINAL AND PLATE ASSEMBLY (D) AWAY FROM CASE (E) AND REMOVE SCREW (F) FROM TERMINAL.



STEP 2. REMOVE GASKET (A) AND CONTACT ASSEMBLY (B). DISCARD GASKET (A).



STEP 3. REMOVE FOUR HEX NUTS (P AND Q), FOUR LOCK WASHERS (N), TWO FLAT WASHERS (M), TWO INSULATORS (L), AND TWO INSULATING BUSHINGS (K). SEPARATE TERMINAL PLATE (J), TERMINAL STUD INSULATION STRIP (H), TERMINAL (G), AND TERMINAL STUDS (E AND F).

ORD E57159

FIGURE 17. DISASSEMBLING SOLENOID RELAY.

### 23. DISASSEMBLY OF FRAME ASSEMBLY

a. The frame assembly supports the field coils, pole shoes, and field coil terminal stud.

b. Disassemble the frame assembly as shown

in figures 18 and 19.

Note. Do not remove field coil unless inspection (par. 26i) indicates replacement is necessary.

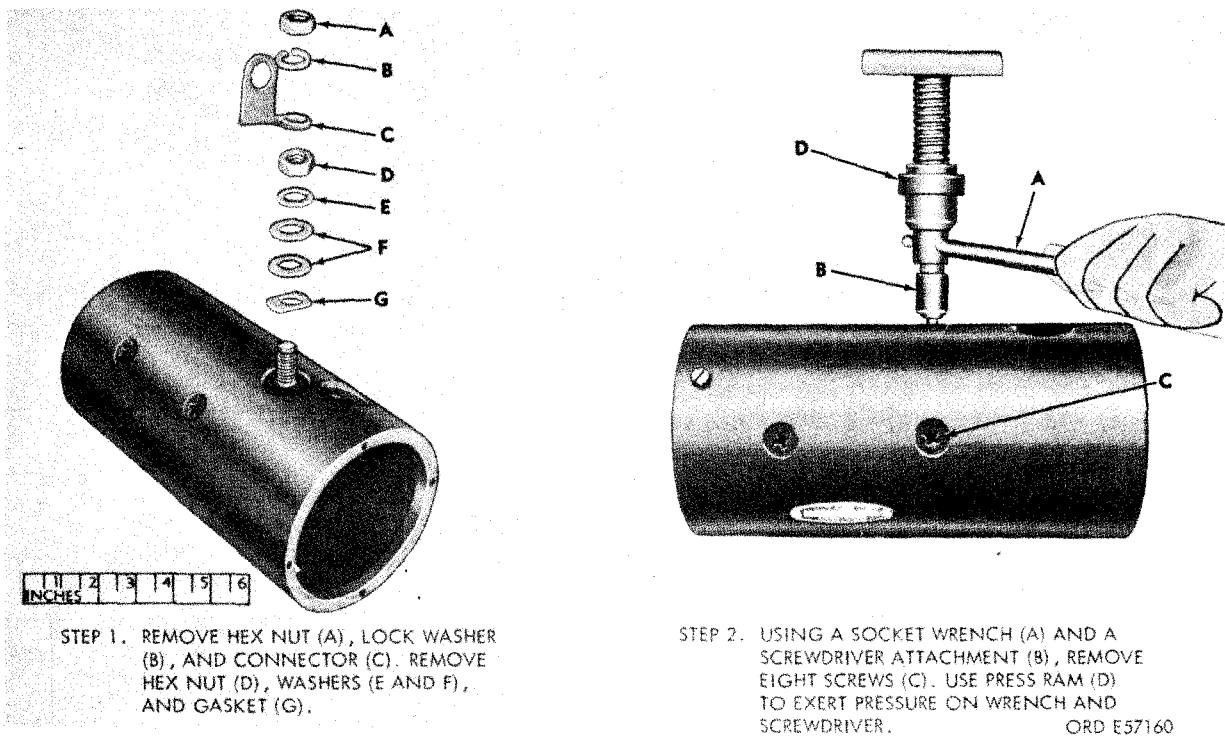
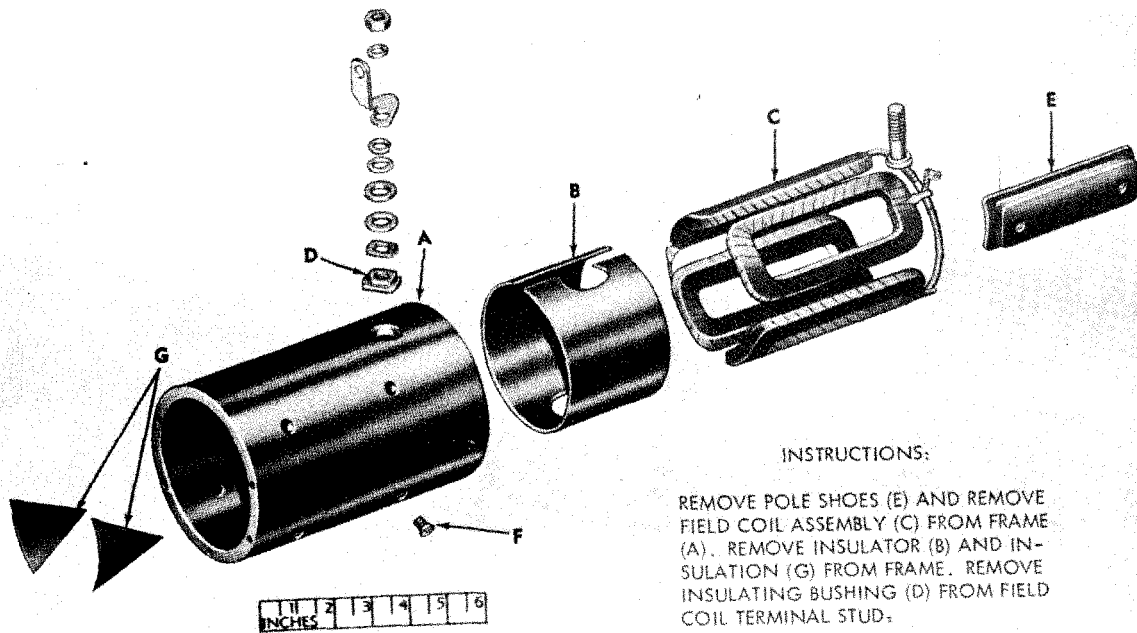


FIGURE 18. REMOVING FIELD COILS.



ORD E57161

FIGURE 19. FIELD COILS SEPARATED FROM FRAME.

### Section III. CLEANING, INSPECTION, AND REPAIR

#### 24. GENERAL

This section contains instructions for cleaning, inspection, and repair or replacement of the parts of the starter. The following general procedures should be followed, where applicable.

a. Inspect all bolts, screws, nuts, and plugs for worn or damaged threads. Discard and replace all defective parts.

b. Discard and replace all preformed packings, gaskets, and oil seals. Appendix II, Repair Parts, lists a gasket and preformed packing set for the starter.

#### 25. CLEANING

a. General. Special cleaning instructions for electrical parts are detailed below. Clean all other parts in dry cleaning solvent or mineral spirits paint thinner and dry with compressed air.

b. Field Coils. Clean field coils and frame thoroughly with a cloth dampened with dry cleaning solvent. Be careful not to damage protective insulation coating. Dry thoroughly with compressed air.

c. Armature. Remove loose particles from armature with compressed air and wipe with a clean cloth dampened with dry cleaning solvent. Clean commutator lightly with No. 00 sandpaper and remove all traces of dust with low-pressure compressed air.

d. Brush Holder Assembly. Clean brush holders, springs, and screws with a brush and dry cleaning solvent and dry them thoroughly with compressed air. Clean insulation and plates with a clean cloth dampened with dry cleaning solvent and dry with compressed air.

e. Solenoid Relay. Clean parts with a clean cloth dampened with dry cleaning solvent and dry with low-pressure compressed air.

f. Brushes. Clean brushes with a clean, dry cloth only. Do not permit dry cleaning solvent to contact the brushes.

## 26. INSPECTION

### a. Inspection of Drive Housing.

- (1) Inspect drive housing for cracks and distortion. Replace housing if defective.
- (2) Inspect housing for scratches, burs, and nicks on machined surfaces. Repair as necessary (par. 27a).
- (3) Inspect threads in tapped holes in housing for damaged threads. Replace housing if threads are stripped or damaged beyond repair.
- (4) Inspect sleeve bearing for discoloration, rough spots, score marks, scratches, and nicks.
- (5) Check inside diameter of sleeve bearing. Replace bearing if it does not conform to limits specified in wear limits (par. 41e). If sleeve bearing is removed, check bearing bore in housing. Replace housing if bore does not conform to limits specified in wear limit (par. 41e).

Note. Appendix II, Repair Parts, lists a sleeve bearing set to be used in repair of the starter.

- (6) Inspect wick for tears, fraying, or wear. Replace wick if defective.

### b. Inspection of Commutator End Plate.

- (1) Inspect commutator end plate for cracks and distortion. Replace plate if defective.
- (2) Inspect end plate for scratches, burs, and nicks on machined surfaces.
- (3) Inspect threads in tapped holes of end plate for damage. Replace end plate if threads are stripped or damaged beyond repair.
- (4) Inspect sleeve bearing for discoloration, rough spots, score marks, scratches; and nicks.

- (5) Check diameter of sleeve bearing. Replace bearing if it does not conform to limits specified in wear limits (par. 41e). If sleeve bearing is removed, check bearing bore in end plate. Replace end plate if bore does not conform to limits specified in wear limits (par. 41e).

Note. Appendix II, Repair Parts, lists a sleeve bearing set to be used in repair of the starter.

- (6) Inspect wick for tears, fraying, or wear. Replace wick if defective.

### c. Inspection of Brush Holder Assembly and Brushes.

- (1) Check insulation, spacers, plates, and brush holders for distortion and cracks. Replace defective parts.
- (2) Check brushes and springs for cracks or breaks. Check brush spring tension (step 1, fig. 10) for conformity to wear limits (par. 41a). If any brushes are defective, replace entire set with brush kit. Replace springs if they do not conform to wear limits.
- (3) Inspect terminal plate stud for damaged threads.

### d. Inspection of Armature.

- (1) Check armature shaft and commutator for conformity to wear limits (par. 41e). Replace the armature if worn beyond limits specified.
- (2) Inspect armature for grounds with a test light by touching one of the test probes to the armature core and the other probe to one of the commutator bar risers (fig. 20). Test all commutator bars in this manner. If the test light glows, the armature is grounded and must be replaced.
- (3) Inspect armature for short circuits using a growler fixture. Place the armature in the growler as shown in figure 21. Hold a thin strip of steel, such as a hacksaw blade about 1/32 inch away from armature. While holding the steel strip in position, rotate the arma-

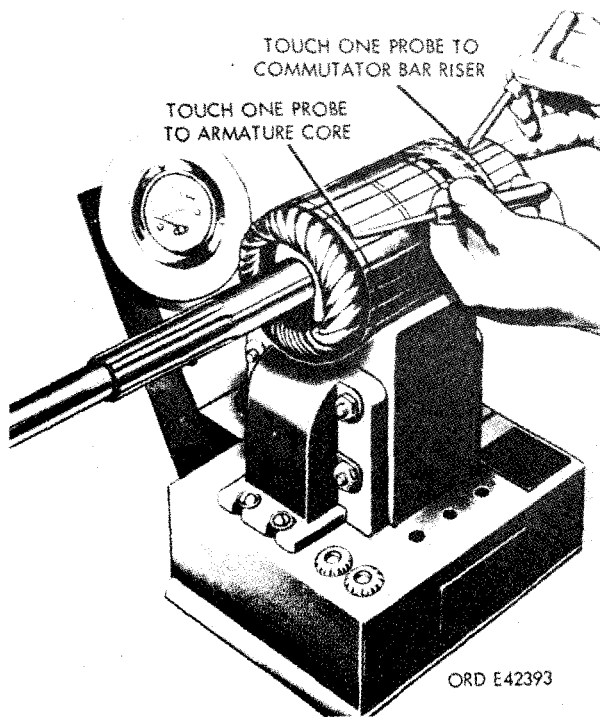


FIGURE 20. TESTING ARMATURE FOR GROUNDS.

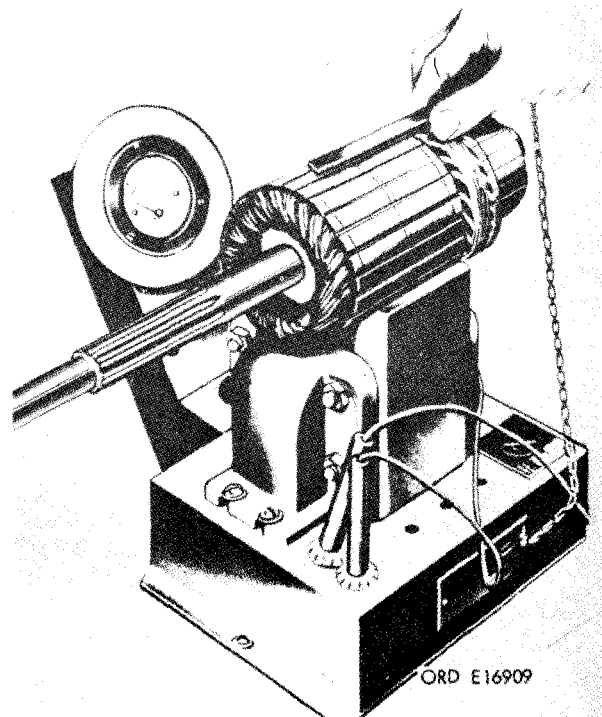


FIGURE 21. TESTING ARMATURE FOR SHORT CIRCUITS USING A GROWLER.

ture slowly in the growler. A short circuit will pull the steel strip tightly against the armature core and cause the strip to vibrate. If a short circuit is found, the armature must be replaced.

- (4) Inspect armature shaft and commutator for runout using a lathe or "V" blocks and a dial indicator (fig. 22). If the runout does not conform to wear limits (par. 41f), the commutator must be resurfaced providing the diameter will not be below the limits specified in wear limits. If refinished diameter of commutator exceeds the limit, the armature must be replaced.
- (5) Inspect armature shaft splines for wear or damage. Replace the armature if the splines are defective.
- (6) Inspect the commutator contact surface. A satisfactory condition is indicated by an even, highly burnished, dark-copper

color. If the contact surface is rough, pitted, scored, burned, or coated with hard carbon or oil, the commutator must be resurfaced. If mica is not 0.025 to 0.032 inch below surface of commutator, it must be undercut to the correct depth.

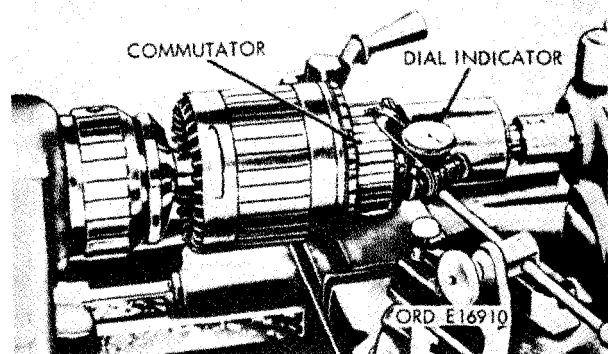


FIGURE 22. CHECKING COMMUTATOR RUNOUT.

e. Inspection of Drive Clutch.

- (1) Inspect drive pinion for broken, chipped, or badly worn teeth. Replace pinion if defective.
- (2) Inspect internal splines in shell and pinion and external splines on sleeve for cracked, chipped, or broken condition. Replace defective parts.
- (3) Inspect all splines and pinion teeth for nicks and burs.
- (4) Inspect sleeve bearing for discoloration, rough spots, score marks, scratches, and nicks.
- (5) Check diameter of sleeve bearing. Replace bearing if it does not conform to limits specified in wear limits (par. 41e). If sleeve bearing is removed, check bearing bore in sleeve. Replace sleeve if bore does not conform to limits specified.
- (6) Check helical compression spring for conformance with wear limits (par. 41g). Replace spring if not within limits specified.
- (7) Inspect shell for cracked or broken condition. Inspect shell for rough spots, nicks, and scratches on internal polished surface. Replace shell if defective.
- (8) Inspect sprags for nicks, scratches, chips, cracks, and broken condition. Inspect sprag (garter) spring for elongation and distortion. If any parts are defective, replace complete set of sprags and spring.

f. Inspection of Lever Housing.

- (1) Inspect lever housing for cracks and distortion. Replace housing if defective.
- (2) Inspect lever housing for scratches, burs, and nicks on machined surfaces.
- (3) Inspect threads in tapped holes in lever housing. Replace housing if threads are stripped or damaged beyond repair.
- (4) Inspect sleeve bearing for discoloration, rough spots, score marks, scratches, and nicks.

- (5) Check inside diameter of sleeve bearing. Replace bearing if it does not conform to limits specified in wear limits (par. 41e). If sleeve bearing is removed, check bearing bore in housing. Replace housing if bore does not conform to limits specified.
- (6) Check lever shaft bores and oil seal bore in housing. Replace housing if bores do not conform to limits specified in wear limits (par. 41e).
- (7) Inspect wick for tears, fraying, or wear. Replace wick if defective.

g. Inspection of Shift Lever, Shaft, Solenoid Plunger, Bellows, and Spring.

- (1) Inspect shift lever for cracks or distortion. Check shaft bore in shift lever. Replace lever if defective or if bore does not conform to limits specified in wear limits (par. 41c).
- (2) Inspect shift lever clutch contact surfaces for rough spots, scratches, and nicks.
- (3) Inspect solenoid plunger for cracks or distortion. Inspect plunger rod threads for stripped or damaged condition. Replace plunger if defective.
- (4) Inspect bellows for tears, punctures, and deterioration. Replace bellows if defective.
- (5) Inspect solenoid plunger compression spring for cracks and distortion. Check spring for conformance with wear limits (par. 41d). Replace spring if defective.

Note. Appendix II, Repair Parts, lists a parts kit for repair of the starter solenoid.

- (6) Inspect lever shaft for rough spots, scratches, and nicks. Check diameter of shaft for conformance with wear limits (par. 41c). Replace shaft if defective.

h. Inspection of Solenoid Relay.

- (1) Inspect case and windings for cracked or broken condition. Check windings

for shorts or grounds with an ohmmeter. Replace solenoid relay if case and windings are defective.

- (2) Inspect contact assembly for cracks, warpage, or broken springs. Replace contact assembly if defective. Inspect contacts on terminal studs for burning or pitting. Replace studs if contacts are defective.

i. Inspection of Frame Assembly.

- (1) Inspect frame for cracks or distortion. Replace frame if defective. Inspect tapped holes in frame. Replace frame if threads are stripped or damaged beyond repair.
- (2) Check field coils for insulation breakdown with ohmmeter. Attach one probe of the ohmmeter to the frame and the other probe to one of the field coil terminals. The minimum reading should not be less than one megohm. Replace defective coils.
- (3) Inspect terminal screw for damaged threads. Replace if threads are stripped or damaged beyond repair.

j. Thrust Washer and Spacer.

- (1) Inspect thrust washer and spacer for cracked or deformed condition. Replace defective parts.
- (2) Check thickness of washer and spacer. Replace washer or spacer if it does not conform to limits specified in wear limits (par. 41b).

27. REPAIR

Note. The following subparagraphs cover only those parts wherein a repair operation will return the damaged part to serviceable condition. Parts not detailed herein must be replaced when they fail to pass the required inspection (par. 26).

a. Repair of Drive Housing.

- (1) Smooth minor scratches, burs, and dents on machined surfaces of drive housing using a fine mill file.
- (2) Repair damaged threads in drive housing.

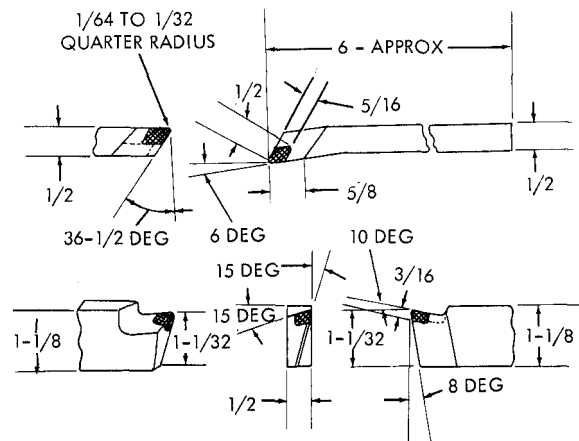
- (3) Smooth minor rough spots, scratches, and nicks from inside bore of sleeve bearing using a fine stone or crocus cloth dipped in dry cleaning solvent.

b. Repair of Commutator End Plate.

- (1) Smooth minor scratches, burs, and dents on machined surfaces of end plate using a fine mill file.
- (2) Repair damaged threads of end plate.
- (3) Smooth minor rough spots, score marks, and scratches in inside bore of sleeve bearing using a fine stone or crocus cloth dipped in dry cleaning solvent.

c. Repair of Brush Holder Assembly.

- (1) Inspect insulations, plates, spacers, and brush holders for distortion and cracks. Replace defective parts.
- (2) Check brushes for cracks and excessive wear. Check springs for cracks and distortion. Check brushes and spring tension (step 1, fig. 10) for conformity to wear limits (par. 41a). If any brushes are defective, replace entire set with brush kit. Replace springs if they do not conform to wear limits.

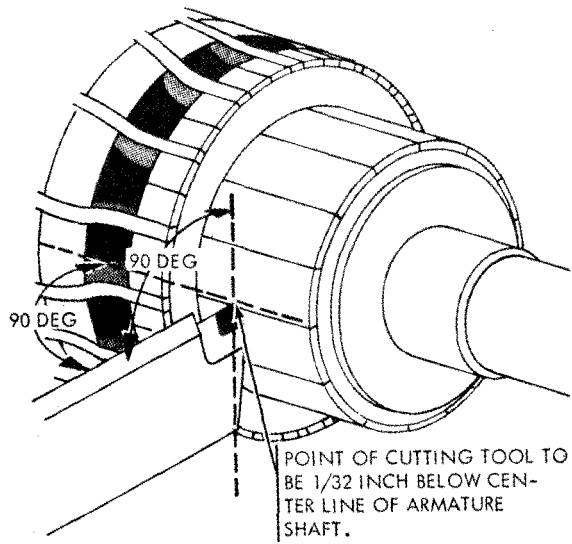


NOTE. ALL DIMENSIONS SHOWN ARE IN INCHES

ORD E16911

FIGURE 23. CUTTING TOOL SHARPENING DIMENSIONS.



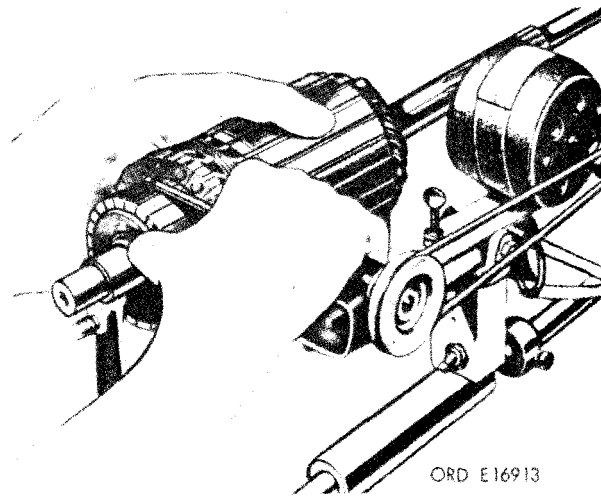


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FIGURE 24. PROPER POSITION OF CUTTING TOOL.

d. Repair of Armature.

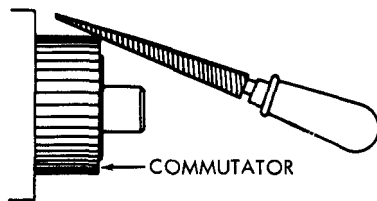
- (1) Resurfacing. Sharpen lathe cutting tool to the dimensions given in figure 23. After grinding, hone the tool with a fine



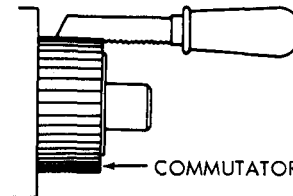
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FIGURE 25. UNDERCUTTING MICA USING A POWER-DRIVEN TOOL.

hard stone to ensure a smooth cut during the turning operations. Position the tool with respect to the commutator as shown in figure 24. Resurface the 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 commu-



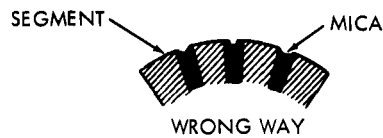
START GROOVE IN MICA WITH 3 CORNERED FILE.



UNDERCUT MICA WITH PIECE OF HACKSAW BLADE.



MICA MUST BE CUT AWAY CLEAN BETWEEN SEGMENTS.



MICA MUST NOT BE LEFT WITH A THIN EDGE NEXT TO SEGMENTS.

ORD E16914

FIGURE 26. UNDERCUTTING MICA USING AN ALTERNATE HAND METHOD.

tator against limits specified in wear limits (par. 41f) and undercut mica ((2) below) if refinished commutator is within limits specified. Replace armature if commutator does not conform to measurements specified.

- (2) Undercutting mica. After resurfacing the commutator, undercut mica to a depth of 0.025 to 0.032 inch below the surface of the commutator using a power-driven undercutting tool (fig. 25). If a power-driven tool is not available, the mica may be undercut by hand as shown in figure 26.

Note. Use care in undercutting. Do not widen commutator slots by removing metal from segments, and do not leave thin edge of mica next to segments. Figure 26 illustrates examples of good and bad undercutting.

- (3) Polishing commutator. After the mica has been undercut, remove all copper and mica particles with compressed air. Polish the commutator in a lathe with No. 2/0 sandpaper (fig. 27) while the armature is rotating at 1500 rpm. After polishing the armature, check that the diameter is within the limits specified in wear limits (par. 41f).

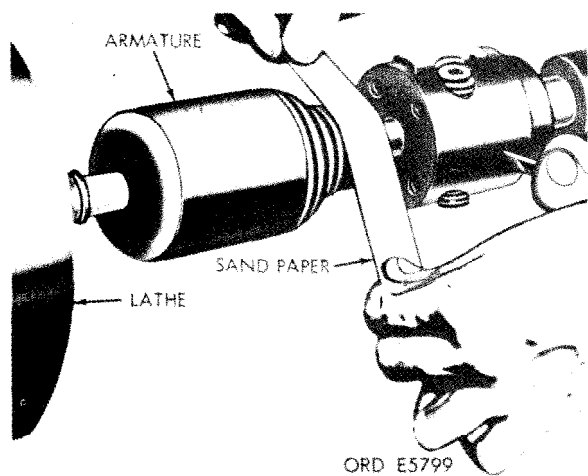


FIGURE 27. POLISHING COMMUTATOR WITH SANDPAPER.

#### e. Repair of Drive Clutch.

- (1) Smooth burs, nicks, and rough spots on splines and pinion teeth using a fine stone or crocus cloth dipped in dry cleaning solvent.
- (2) Smooth rough spots, scoring, scratches, and nicks on inside bore of sleeve bearings and all surfaces of bronze bearings using crocus cloth dipped in dry cleaning solvent.
- (3) Smooth minor rough spots, nicks, and scratches on internal polished surface of shell using a fine stone or crocus cloth dipped in dry cleaning solvent. If nicks and scratches cannot be removed or surface cannot be restored to original finish, replace the shell.

#### f. Repair of Lever Housing.

- (1) Smooth minor scratches, burs, and nicks on machined surfaces of lever housing using a fine mill file.
- (2) Repair damaged threads in housing.
- (3) Smooth minor rough spots, scoring, scratches, and nicks on inside bore of sleeve bearing using a fine stone or crocus cloth dipped in dry cleaning solvent.

#### g. Repair of Shift Lever, Shaft and Solenoid Plunger.

- (1) Smooth minor rough spots, scratches, and nicks on clutch contact surfaces of shift lever using a fine stone. Smooth minor rough spots, scratches, and nicks on lever shaft using a fine stone.
- (2) Repair damaged threads on plunger rod.

#### h. Repair of Frame.

- (1) Smooth minor scratches, burs, and nicks on machined surfaces of frame using a fine mill file.
- (2) Repair damaged threads in frame. Repair damaged threads on field coil terminal stud.

## Section IV. ASSEMBLY

### 28. GENERAL

a. The assembly procedures are covered in the following paragraphs of this section. Reference should be made during assembly and installation to the exploded views in the disassembly section for the proper relationship and position of components.

b. Apply thread sealer to pole shoe screws, pipe plugs, and solenoid relay mounting screws before assembly.

c. An oil hole must be drilled in the lever housing, commutator end plate, and drive housing sleeve bearing after installation. If any sleeve bearings are replaced, they must be reamed or burnished to the dimensions specified in the "Sizes and fits of new parts" column of the wear limits (par. 41e) after installation in housings, end plate, or clutch sleeve.

### 29. LUBRICATION

The lubricants listed in Table II should be

available for use during assembly. Table II lists the lubricant, the part to which it is to be applied, and the method of application. Make certain that these instructions are performed during assembly.

### 30. ASSEMBLY OF FRAME ASSEMBLY

Note. The key letters shown below in parentheses refer to figure 19 except where otherwise indicated.

a. Install terminal stud insulator bushing (D) on field coil terminal stud and position field coil (C) in frame (A). Install insulator (B) and two insulations (G) between frame and field coils.

b. Position each of four pole shoes (E), in turn, on coil inside frame align mating holes and secure each pole shoe with two pole shoe screws (refer to step 2, fig. 18). Coat threads of pole shoe screws with a suitable thread sealer before installation.

TABLE II. Lubrication Instructions

| Par. ref.   | Point of lubrication                        | Lubricant   | Instructions  |
|---|---|---|---|
| <u>32a</u><br>and<br><u>35c</u>                   | Clutch and armature splines.                | GREASE, AIRCRAFT<br>and INSTRUMENT (GL).                    | Coat splines.   |
| <u>32b</u> ,<br><u>33b</u> ,<br>and<br>34         | Felt wicks and felt plugs.                  | LUBRICATING OIL,<br>INTERNAL COMBUS-<br>TION ENGINE (OE 10) | Soak wick and<br>plugs until<br>saturated.            |
| 32a   | Clutch sprags.                              | LUBRICATING OIL,<br>INTERNAL COMBUS-<br>TION ENGINE (OE 10) | Lightly coat<br>sprags.                               |
| 35b   | Clutch shell (shift lever contact surface). | GREASE, AIRCRAFT<br>and INSTRUMENT (GL).                    | Coat surface.   |
| <u>32b</u> ,<br><u>32c</u> ,<br>and<br><u>35c</u> | Preformed packings and gaskets.             | GREASE, GENERAL<br>PURPOSE, medium<br>grade.                | Lightly coat<br>preformed<br>packings and<br>gaskets. |

c. Refer to figure 18, step 1 and install gasket (G), two nonmetallic washers (F), 0.520 ID, 7/8 OD, 0.031 thick flat washer (E), 1/2-inch hex nut (D), field coil terminal-to-solenoid relay connector (C), 1/2-inch lock washer (B), and 1/2-inch hex nut (A).

d. Varnish inside of frame and coil assembly. Leave 0.38 inch from each end of frame free of varnish. Allow varnish to dry thoroughly before assembling starter.

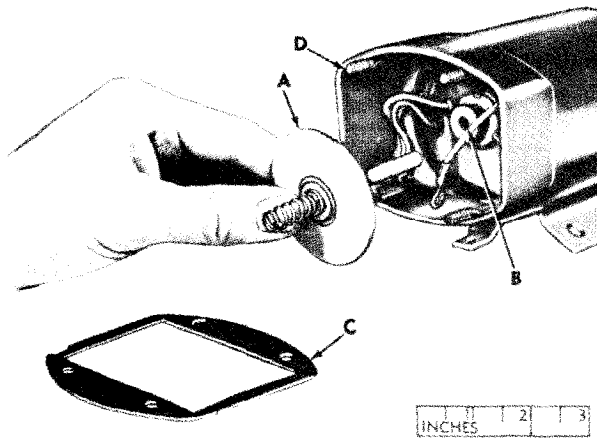
### 31. ASSEMBLY OF SOLENOID RELAY

Note. The key letters shown below in paren-

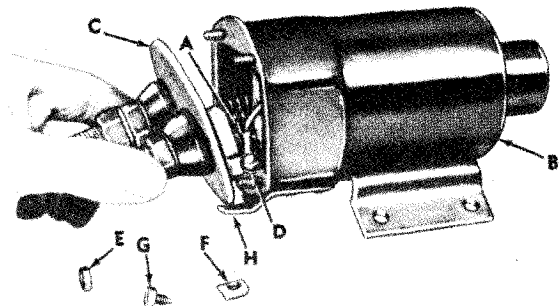
theses refer to figure 17, step 3 except where otherwise indicated.

a. Install terminal (G) on motor terminal stud (E) (short stud). Install motor terminal stud, battery terminal stud (F), terminal stud insulation strip (H), and terminal plate (J) with motor terminal stud in plate hole marked "MOTOR". Install one insulating bushing (K), one insulator (L), one 0.516 ID, 7/8 OD, 1/32 thick flat washer (M), two 1/2-inch lock washers (N), one 1/2-inch, 0.310 thick hex nut (P), and 1/2-inch, 0.438 thick hex nut (Q) on each terminal stud.

b. Refer to figure 28 and complete assembly of solenoid relay.



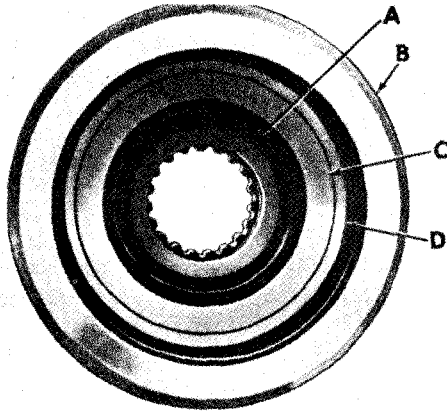
STEP 1. INSTALL SHAFT OF CONTACT ASSEMBLY (A) INTO HOLE (B) IN CASE. INSTALL GASKET (C) ON CASE STUDS (D).



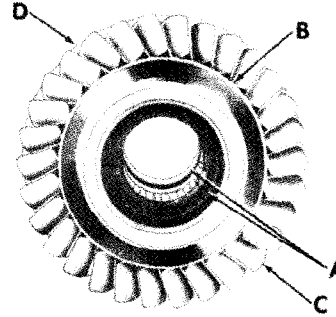
STEP 2. CONNECT COIL CONNECTION (A) OF CASE (B) TO TERMINAL ON TERMINAL AND PLATE ASSEMBLY (C). INSTALL SCREW (D). INSTALL TERMINAL AND PLATE ASSEMBLY ON CASE STUDS AND SECURE WITH FOUR NO. 10 HEX EXTENDED WASHER NUTS (E). INSTALL A TERMINAL CLIP (F) AND TERMINAL SCREW (G) ON EACH TERMINAL (H).

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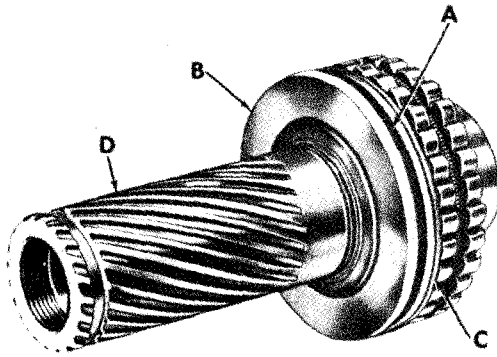
FIGURE 28. ASSEMBLING SOLENOID RELAY.



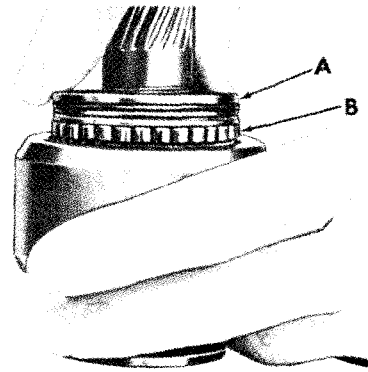
STEP 1. INSTALL SEALING WASHER (A) IN SHELL (B). PRESS BEARING (C) INTO SHELL TO A MINIMUM OF 1.057 INCHES FROM FACE OF SHELL. INSTALL THRUST WASHER (D).



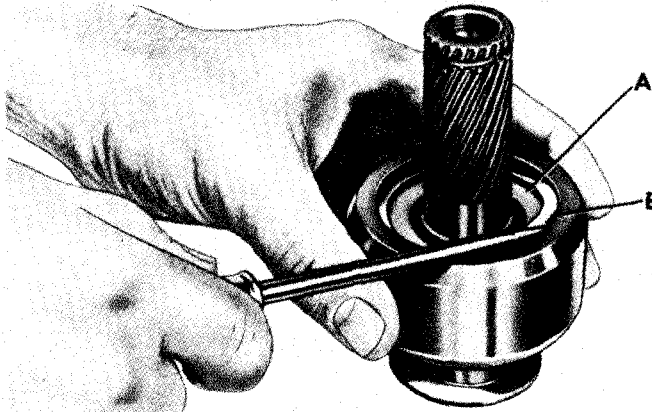
STEP 2. DURING ASSEMBLY, APPLY GREASE (GL) BETWEEN BEARINGS. IF SLEEVE BEARINGS (A) WERE REMOVED, PRESS NEW BEARINGS INTO SLEEVE (B). INSTALL 30 SPRAGS (C) ON DRIVE SLEEVE IN POSITION SHOWN. SECURE SPRAGS WITH SPRAG (GARTER) SPRING (D).



STEP 3. INSTALL PREFORMED PACKING (A) ON BEARING (B) AND INSTALL THRUST WASHER (C) ON BEARING. INSTALL BEARING ON SLEEVE (D). HOLD BEARING AGAINST SHOULDER ON SLEEVE AND PUSH SPRAGS AGAINST BEARING.



STEP 4. BEFORE ASSEMBLING, ADD 0.5 TO 0.6 INCH OF OIL (OE) INTO SHELL. HOLDING BEARING (A) AGAINST SHOULDER ON SLEEVE, POSITION SPRAGS (B) IN OPENING IN SHELL, TURN SLEEVE CLOCKWISE WHILE EXERTING PRESSURE INWARD TOWARDS SHELL UNTIL BEARING ENTERS SHELL.



STEP 5. PRESS IN BEARING (A) UNTIL IT IS 0.228 TO 0.234 INCHES FROM FACE OF SHELL. INSTALL RETAINING RING (B).

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FIGURE 29. ASSEMBLING INTERNAL PARTS OF DRIVE CLUTCH ASSEMBLY.

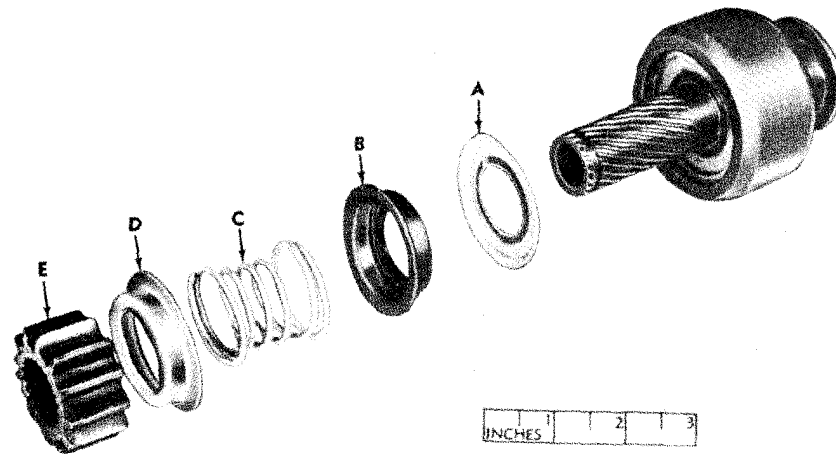
## 32. ASSEMBLY OF DRIVE CLUTCH AND LEVER HOUSING

a. Assembly of Drive Clutch. Refer to figures 29 and 30 and assemble the drive clutch. After clutch has been assembled, it must be checked for slippage.

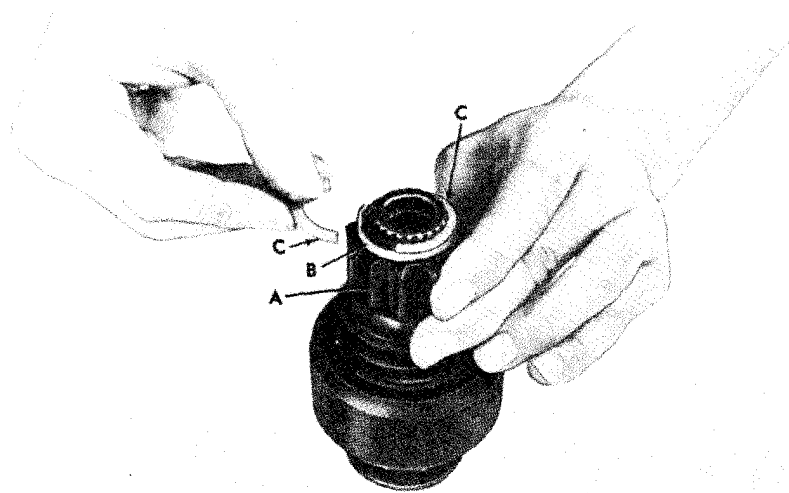
(1) With clutch held stationary, the pinion must slip when 4000 pound-inches is

applied in direction of torque. Torque is counterclockwise as viewed from pinion end.

(2) With clutch held stationary, twelve pounds pressure must be required to move pinion to "stop" position, with a 16 degree, 15 minute clockwise motion viewing pinion end.



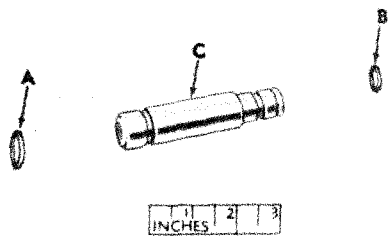
STEP 1. INSTALL BAFFLE (A), SPRING CUP (B), AND SPRING (C). INSTALL SPRING CUP (D) ON DRIVE PINION (E) AND INSTALL CUP AND PINION ON SLEEVE.



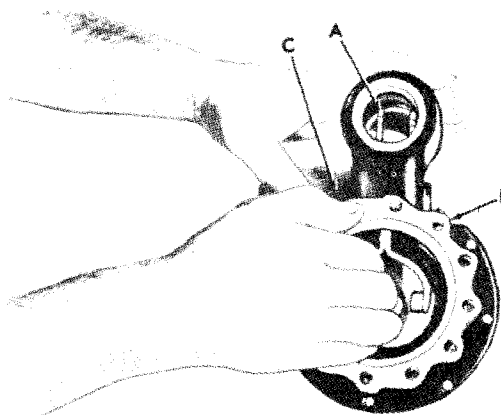
STEP 2. PRESS PINION (A) DOWN AGAINST SPRING AND INSTALL WASHER CUP (B) AND SPLIT WASHERS (C). RELEASE PINION SLOWLY. ROLL EDGE OF WASHER CUP OVER SPLIT WASHERS.

ORD E57164

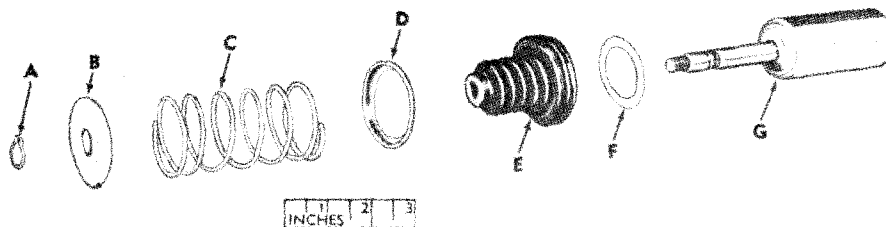
FIGURE 30. ASSEMBLING EXTERNAL PARTS OF DRIVE CLUTCH ASSEMBLY.



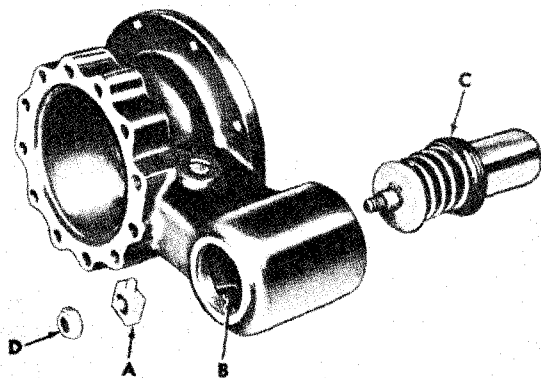
STEP 1. GREASE PREFORMED PACKINGS (A and B) AND INSTALL PACKINGS ON LEVER SHAFT (C).



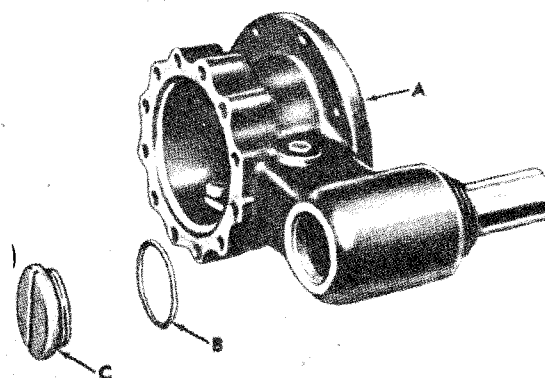
STEP 2. INSTALL SHIFT LEVER (A) IN LEVER HOUSING (B) WITH GUIDE SLOTS IN LEVER TOWARD THE OUTSIDE. PUSH LEVER SHAFT (C) THROUGH HOLES IN LEVER HOUSING AND LEVER. SECURE SHAFT WITH RETAINING RING.



STEP 3. ASSEMBLE FLAT WASHER (F) ON SOLENOID PLUNGER (G). INSTALL RUBBER BELLOWS (E), SPRING RETAINER (D), SPRING (C), AND SPRING RETAINER (B). COMPRESS SPRING AND INSTALL RETAINING RING (A) ON SHAFT.



STEP 4. INSTALL PLUNGER ROD GUIDE (A) ON SHIFT LEVER IN HOUSING WITH GUIDE LUGS IN SLOTS (B) IN LEVER. INSTALL ASSEMBLED PLUNGER, SPRING, AND BELLOWS (C) WITH PLUNGER SHAFT THROUGH HOLE IN GUIDE. INSTALL 5/16-INCH SELF-LOCKING HEX NUT (D). TIGHTEN JUST ENOUGH TO SECURE PARTS.



STEP 5. GREASE PREFORMED PACKING AND INSTALL IN GROOVE INSIDE LEVER HOUSING FLANGE (A). INSTALL GASKET (B) AND INSPECTION PLUG (C) BUT DO NOT TIGHTEN PLUG.

ORD E57165

FIGURE 31. INSTALLING SOLENOID PLUNGER AND LEVER.

b. Assembly of Lever Housing. Refer to figure 14 and assemble the lever housing as follows:

- (1) Install sleeve bearing (G) in lever housing (F). Ream sleeve bearing bore to limits specified in wear limits (par. 41c).
- (2) Saturate wick (A) and felt plug (C) with oil (OE). Apply sealer to expansion plug seat. Install wick (A), felt plug (C), and expansion plug (D). Fill reservoir with oil (OE) and install pipe plug (B).
- (3) Apply sealer to oil seal counterbore and install new oil seal (E).

c. Assembly of Solenoid Plunger and Lever. Refer to figure 31 and install solenoid plunger and lever in lever housing.

### 33. ASSEMBLY OF COMMUTATOR END PLATE ASSEMBLY

a. Assembly of Brush Holder Assembly. Refer to figure 11, step 3 and assemble the brush holder assembly as follows:

- (1) Place insulated brush connection plate (J), brush insulation plate (H), and terminal plate (G) together. Install two nonmetallic washers (K) in each of two adjacent large holes in terminal plate (G).
- (2) Install brush holder plate insulation (L), insulated brush spacer plate (M), and brush holder (E). Secure with a No. 10-32 by 21/32-inch fillister head screw (S) and No. 10 lock washer (R).
- (3) Install two helical torsion springs (Q) and a No. 10 lock washer (P) on insulated brush holder screw (2 inches lg) (T) and install screw.
- (4) Install remaining insulated brush holder following same procedure.
- (5) Install grounded brush spacer plate (F) and brush holder (E) at top of terminal plate (G). Secure with No. 10-32 by 3/8-inch long fillister head screw (U) and a No. 10 lock washer (B).

- (6) Install two brush springs (C) and a No. 10 lock washer (D) on grounded brush holder screw (1-43/64-inch lg) (A) and install screw.
- (7) Install remaining grounded brush holder following same procedure.
- (8) Check for grounded brush holder. Touch one probe of test lamp to terminal plate, and the other probe to the insulated brush holder. If the test lamp lights, a ground is indicated. Disassemble and replace defective parts if a ground is evident.

b. Assembly of Commutator End Plate. Refer to figure 10 and assemble the commutator end plate as follows:

- (1) Install a new bearing (N, step 4) in commutator end plate (A). Ream sleeve bearing bore to limits specified in wear limits (par. 41e).
- (2) Saturate wick (R, step 4) and felt plug (T) with oil (OE).
- (3) Apply sealer to expansion plug seat. Install wick (R, step 4), felt plug (T), and expansion plug (S).
- (4) Fill reservoir with oil and install pipe plug (Q, step 4).
- (5) Install 0.516-inch ID nonmetallic washer (H, step 3) and preformed packing (G) on terminal stud of brush holder assembly (J).
- (6) Install brush holder assembly (J) in commutator end plate (A) and secure with three No. 8 by 1/2-inch pan head screws (M), lock washers (L), and flat washer (K).
- (7) Install bushing (F, step 3), terminal stud insulator (E), 0.520-inch ID flat washer (D), 1/2-inch lock washer (C), and 1/2-inch, 0.310-inch thick hex nut (B).

### 34. ASSEMBLY OF DRIVE HOUSING

Refer to figure 9 and assemble drive housing as follows:



a. Install new sleeve bearing (G) in drive housing (B). Ream sleeve bearing bore to limits specified in wear limits (par. 41e) and drill oil hole.

b. Saturate wick (G), and felt plug (D) with oil (OE).

c. Apply sealer to expansion plug seat. Install wick (G), felt plug (D), and expansion plug (E).

d. Fill reservoir with oil and install pipe plugs (H and F).

e. Install rubber plugs (A) in housing (B).

### 35. ASSEMBLY OF STARTER ASSEMBLY

a. Installation of Solenoid Relay. Refer to figure 32 and install solenoid relay on frame assembly.

b. Installation of Lever Housing and Drive Clutch. Refer to figure 33 and install lever housing drive clutch.

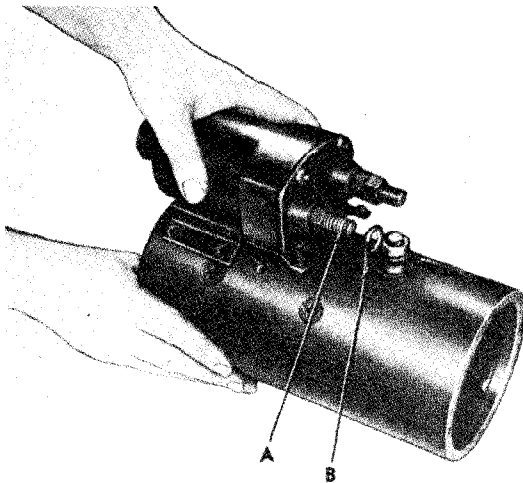
c. Installation of Commutator End Plate Brushes and Armature. Refer to figure 34 and install commutator end plate, brushes, and armature.

If new brushes are to be installed, cut a strip of 2/0 sandpaper the width of the commutator, and install on commutator with sand side out, see step 1.

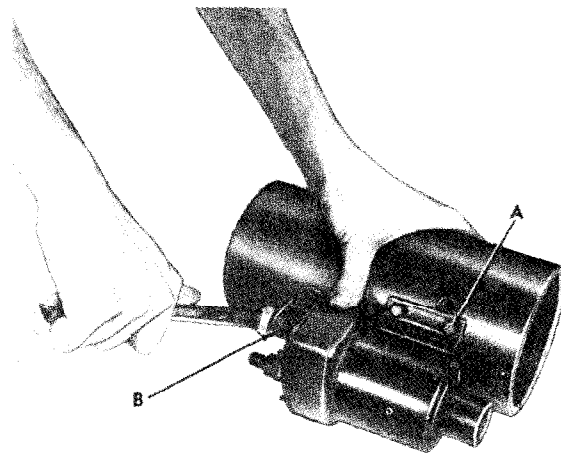
Install commutator end plate on armature. Lift brush springs using improvised brush spring lifter (fig. 3) and install brushes. Brushes must lie flat against sandpaper on commutator to obtain the desired brush seat contour.

Hold armature and carefully rotate commutator end plate assembly in a clockwise direction three to five revolutions to properly seat all brushes.

Lift brush springs and raise each brush and inspect seat contour to determine whether or not the sanding operation is satisfactory. Refer to figure 35 for examples of satisfactory brush seats.



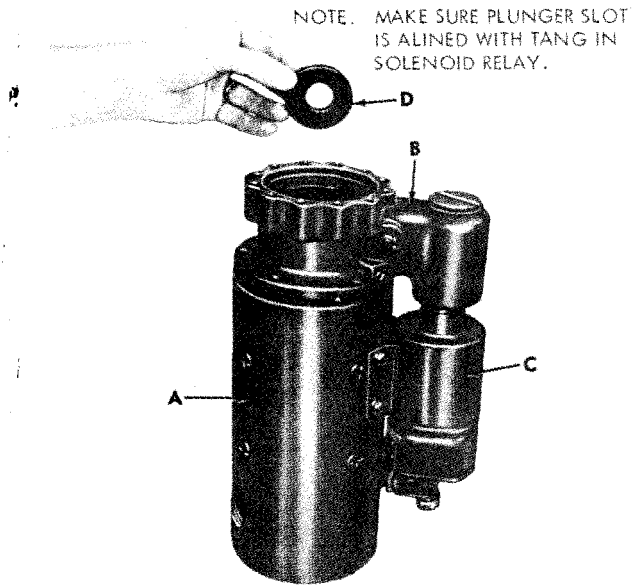
STEP 1. REMOVE 1/2-INCH HEX NUT AND 1/2-INCH LOCK WASHER FROM "MOTOR" TERMINAL STUD ON SOLENOID RELAY (A). SLIDE "MOTOR" TERMINAL STUD INTO CONNECTOR (B) ON FRAME TERMINAL.



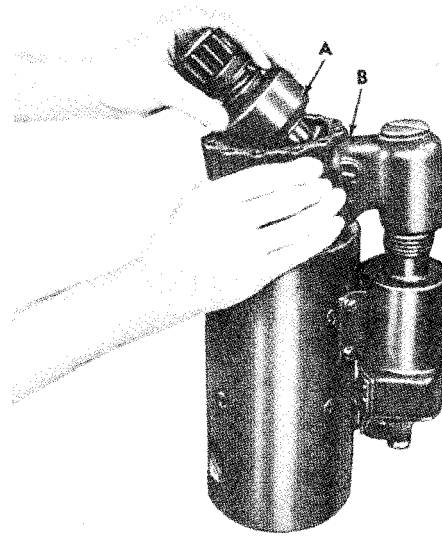
STEP 2. SECURE RELAY TO FRAME WITH FOUR 1/4 BY 5/16-INCH ASSEMBLED WASHER SCREWS (A). INSTALL 1/2-INCH LOCK WASHER AND 1/2-INCH HEX NUT (B) ON "MOTOR" TERMINAL STUD OF SOLENOID RELAY.

ORD E57166

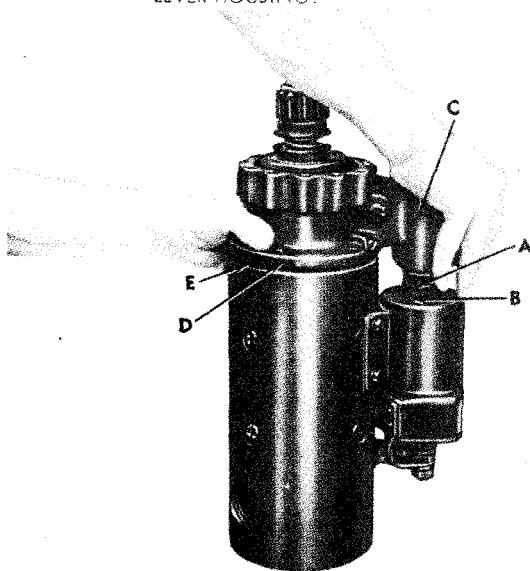
FIGURE 32. INSTALLING SOLENOID RELAY.



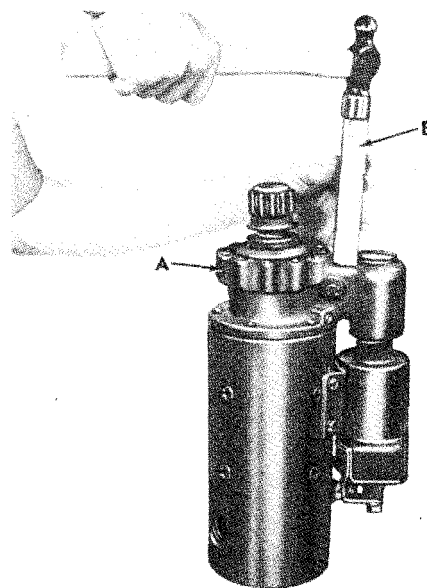
STEP 1. SET FRAME (A) ON END AND POSITION LEVER HOUSING (B) LOOSELY ON FRAME WITH PLUNGER IN SOLENOID RELAY (C). INSTALL NONMETALLIC WASHER (D) IN LEVER HOUSING.



STEP 2. INSTALL DRIVE CLUTCH (A) IN LEVER HOUSING (B). TILT CLUTCH TO ENGAGE LUGS ON SHIFT LEVER.



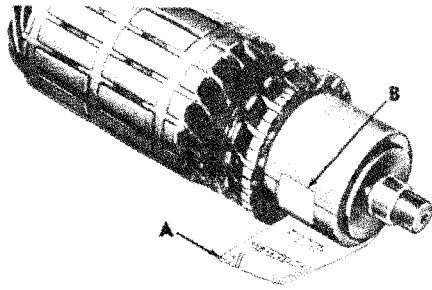
STEP 3. MAKE SURE EDGE OF RUBBER BELLOWS (A) IS NOT CRIMPED AND IS ON OUTSIDE OF SOLENOID CASE (B). PRESS DOWN ON PLUNGER END OF LEVER HOUSING (C) KEEPING FLANGE OF HOUSING (D) LEVEL UNTIL PREFORMED PACKING (E) IS SEATED AGAINST FRAME.



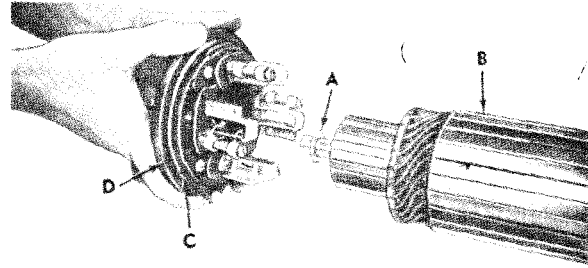
STEP 4. SEAT PREFORMED PACKING BY TAPPING ON LEVER HOUSING (A) WITH A BLOCK OF WOOD (B).

ORD E57167

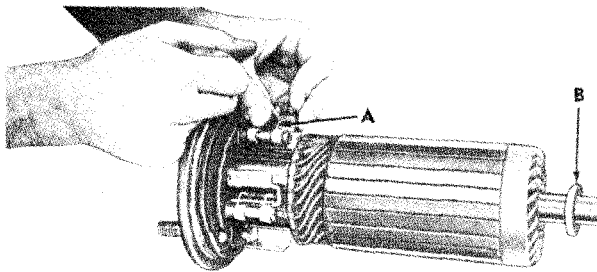
FIGURE 33. INSTALLING LEVER HOUSING AND DRIVE CLUTCH ASSEMBLY.



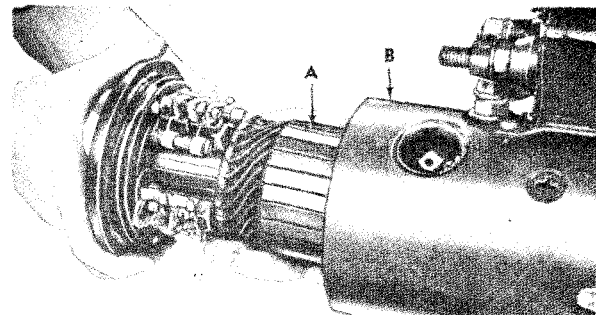
STEP 1. COVER COMMUTATOR WITH NO. 2/0 SANDPAPER (A) AND HOLD IN PLACE WITH MASKING TAPE (B).



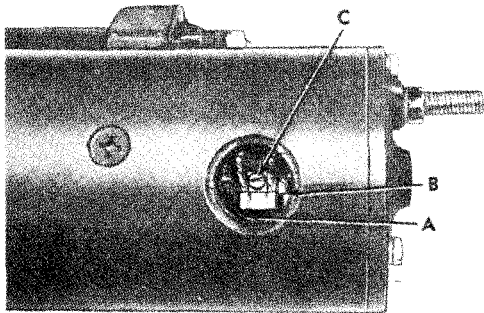
STEP 2. INSTALL THRUST WASHER (A) ON SHAFT OF ARMATURE (B). APPLY GREASE TO PREFORMED PACKING (C) AND INSTALL PACKING ON COMMUTATOR END PLATE. INSTALL COMMUTATOR END PLATE ASSEMBLY (D) ON COMMUTATOR AND ARMATURE SHAFT.



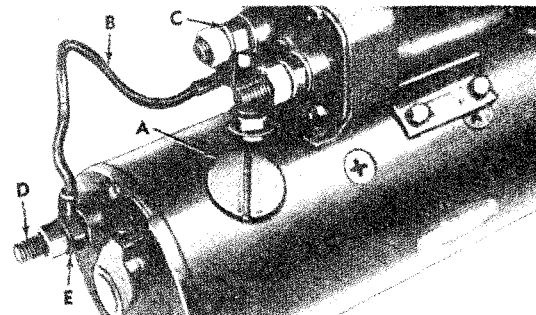
STEP 3. RAISE BRUSH SPRINGS AND INSTALL 8 BRUSHES (A). FOLLOW MARKINGS MADE TO ASSURE ASSEMBLY IN ORIGINAL LOCATIONS. SECURE BRUSH LEADS TO HOLDERS. INSTALL SPACER (B) ON DRIVE END OF ARMATURE SHAFT.



STEP 4. INSTALL ARMATURE (A) AND COMMUTATOR END PLATE ASSEMBLY WITH BRUSHES, AS A UNIT, INTO FRAME (B). ALINE SCRIBED MARKS ON END PLATE AND FRAME AND SECURE END PLATE WITH FOUR HEX HEAD CAP SCREWS AND LOCK WASHERS.



STEP 5. ALINE HOLES IN FIELD LEAD TERMINAL (A), BRUSH LEAD (B), AND BRUSH HOLDER. INSTALL BRUSH LEAD SCREW (C). REPEAT FOR OTHER FIELD LEAD.



STEP 6. INSTALL TWO INSPECTION HOLE PLUGS AND GASKETS (A). SLIDE SLOTTED TERMINAL OF LEAD (B) UNDER TERMINAL CLIP (C) ON SOLENOID RELAY AND TIGHTEN SCREW. INSTALL THE OTHER END OF LEAD ON BRUSH HOLDER TERMINAL STUD (D) AND SECURE WITH HEX NUT AND LOCK WASHER (E).

ORD E57168

FIGURE 34. INSTALLING COMMUTATOR END PLATE, BRUSHES, AND ARMATURE.

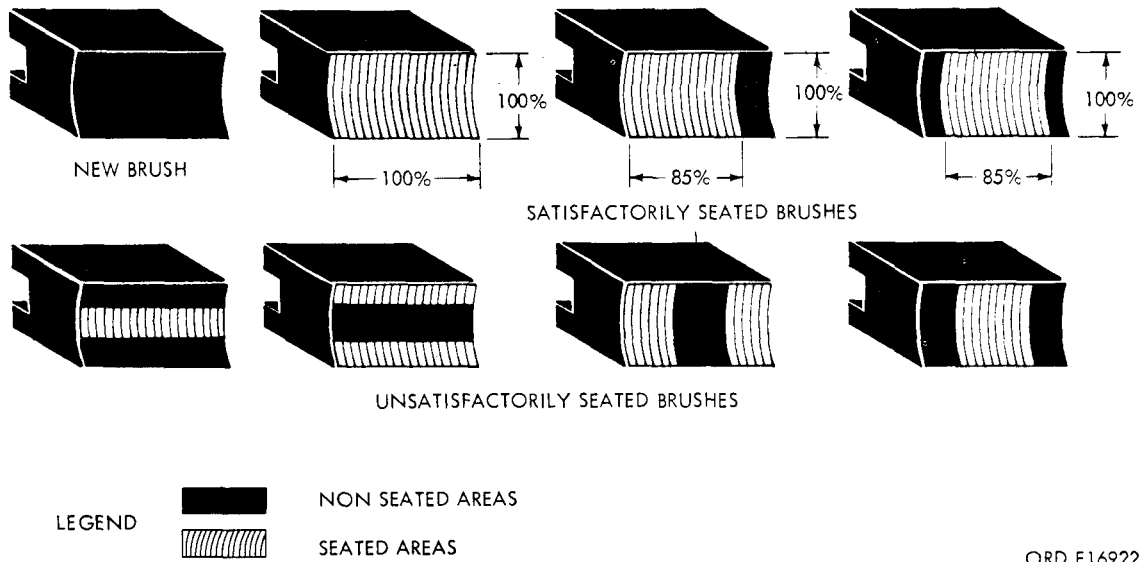
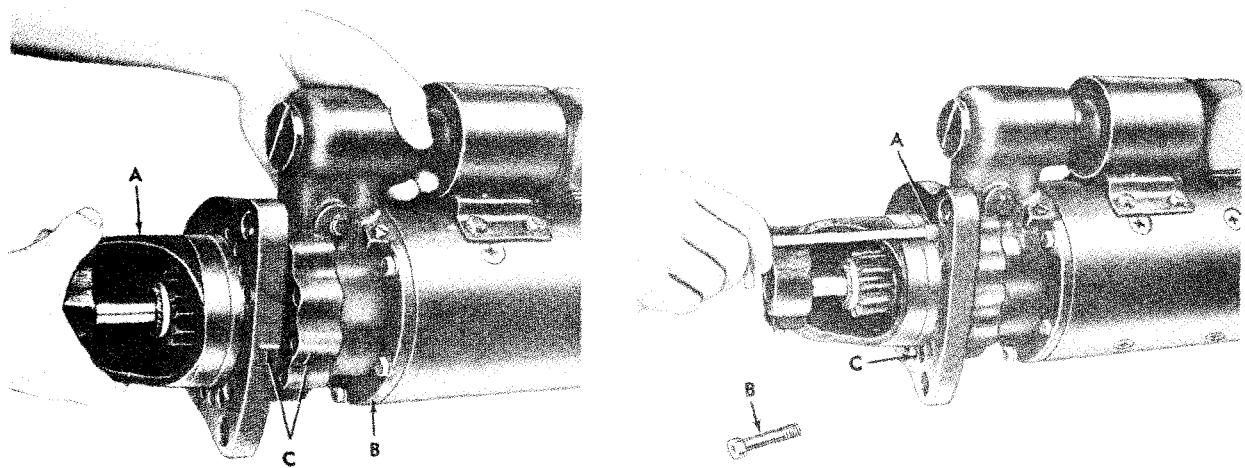


FIGURE 35. EXAMPLES OF SATISFACTORY AND UNSATISFACTORY BRUSH SEATS.



STEP 1. POSITION GASKET IN GROOVE IN LEVER HOUSING. SLIDE DRIVE HOUSING (A) ONTO LEVER HOUSING (B) AND ALINE SCRIBE MARKS (C).

STEP 2. INSTALL A 5/16 X 0.860 INTERNAL WRENCHING BOLT (A) IN HOLE SHOWN. INSTALL FIVE 5/16 X 1-1/2 INTERNAL WRENCHING BOLTS (B) IN REMAINDER OF TAPPED HOLES IN LEVER HOUSING. TIGHTEN ALL BOLTS TO 13-17 LB-FT TORQUE. INSTALL SIX RUBBER PLUGS IN REMAINING HOLES IN DRIVE HOUSING.

ORD E57169

FIGURE 36. INSTALLING DRIVE HOUSING.

- (5) Mark location of brushes, and, remove brushes from holders. Remove commutator end plate from armature. Remove sandpaper, and clean armature, brushes, and commutator end plate. Sanding dust can be removed using compressed air.
- (6) Install commutator end plate, brushes, armature, brush leads and terminal lead following steps 2 through 6, figure 34.

Note. The armature shaft and splines must be coated with grease (GL) before installation. Coat all exposed metal of starter lead and terminals with vinyl latex or equivalent.

d. Installation of Drive Housing. Refer to figure 36 and install drive housing.

### 36. ADJUSTING DRIVE CLUTCH PINION CLEARANCE

a. Check and adjust pinion clearance as described below. Refer to figure 37 for schematic wiring diagram of starter and solenoid connections.

- (1) Remove motor field coil connector from the motor switch terminal stud.
- (2) Remove ground lead assembly connecting motor solenoid terminal and starter ground terminal stud.

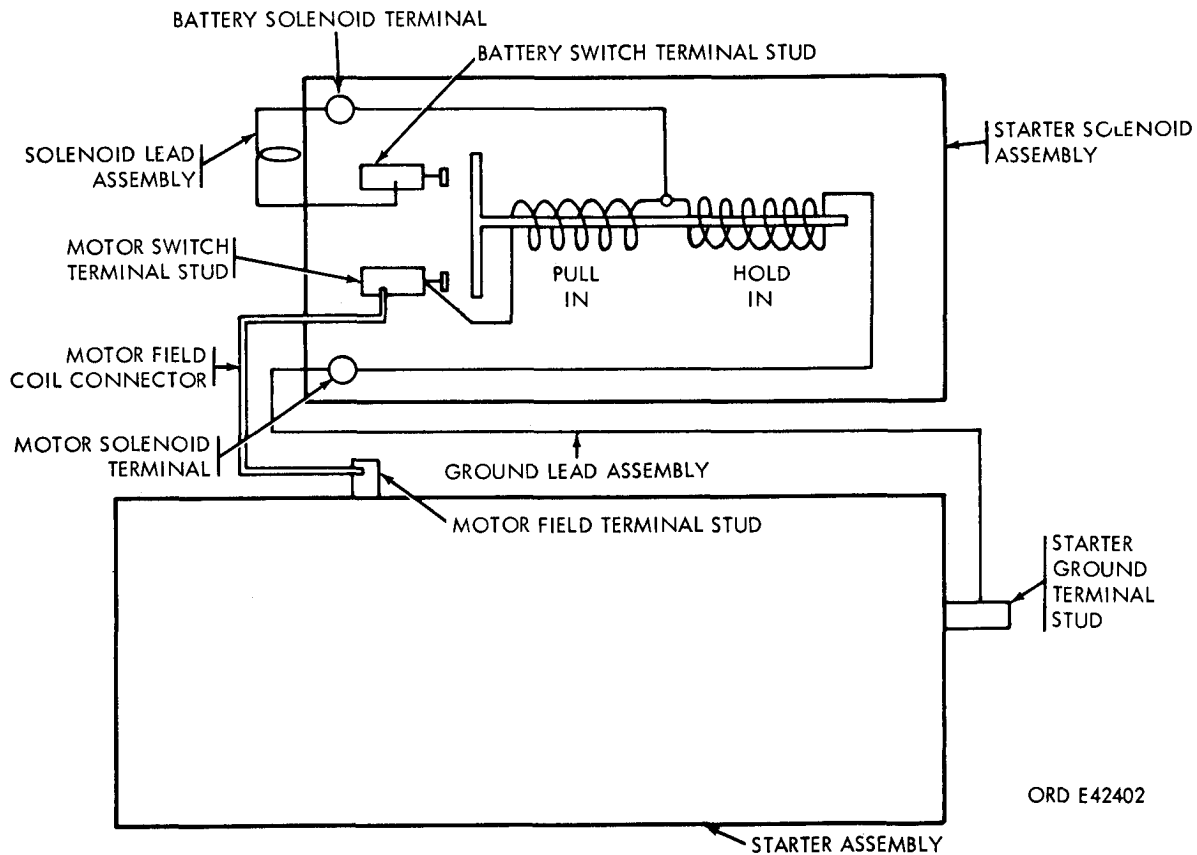


FIGURE 37. STARTER WIRING DIAGRAM - SCHEMATIC.

- (3) Remove solenoid lead assembly connecting battery switch terminal stud and battery solenoid terminal.
- (4) Connect a 24-volt battery supply to battery solenoid terminal and motor solenoid terminal.
- (5) Momentarily hold a jumper lead from the motor switch terminal stud to the motor solenoid terminal. The pinion will now shift into cranking position and remain so until the battery is disconnected.
- (6) Push pinion back toward armature to take up slack movement.
- (7) Remove inspection plug and gasket (B and A, figure 7, step 1) and measure the distance between pinion and drive housing and adjust clearance to  $23/64 \pm 1/32$ -inch by turning shaft nut (fig. 38).

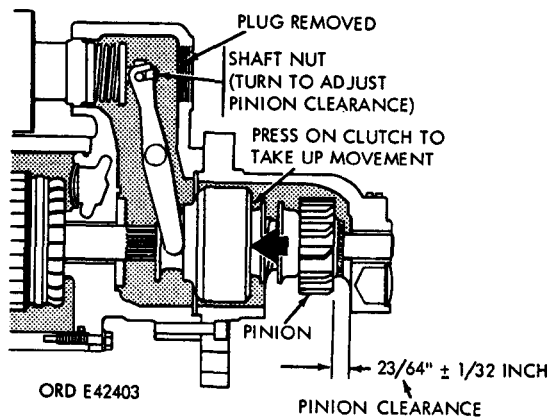


FIGURE 38. ADJUSTING DRIVE CLUTCH PINION CLEARANCE.

b. Perform pinion block check as described below.

- (1) Connect a test light or other continuity checker between the battery switch terminal stud and motor switch terminal stud.

- (2) Connect one of the posts of a 24-volt battery to the battery solenoid terminal. Connect the other battery post to the motor solenoid terminal.
- (3) Place a 1-1/64-inch spacer block (fig. 39) between the pinion and drive housing and momentarily hold a jumper lead from the motor switch terminal stud to the motor solenoid terminal. The pinion will now shift against the spacer and remain so until the jumper lead is disconnected.

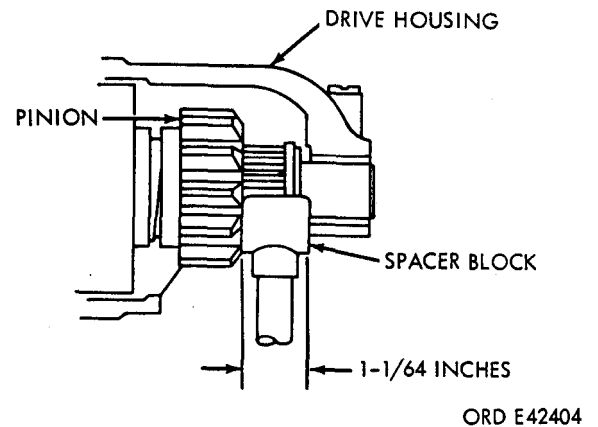


FIGURE 39. PINION BLOCK TEST.

- (4) An open circuit should be indicated between the battery switch and motor switch terminals. If continuity exists, decrease the pinion clearance (a above) to the minimum limit of  $21/64$ -inch and then recheck to make sure an open circuit now exists.
- (5) Disconnect battery and test equipment and install motor field connector, ground lead, and solenoid lead.
- (6) Install plug and gasket.

Section V. TESTING

37. GENERAL

Whenever a starter is tested check for any unusual noises or vibration that might indicate an unserviceable condition. If either condition exists, further testing should not be attempted and the starter must be disassembled and repaired.

38. NO-LOAD TEST AND LOCK TORQUE TEST

Caution: Never operate the starter motor more than 30 seconds at a time. Allow the motor to cool for at least 2 minutes between each cranking cycle. Overheating, caused by excessive cranking, will seriously damage the starter motor.

a.. No-Load. (fig. 40).

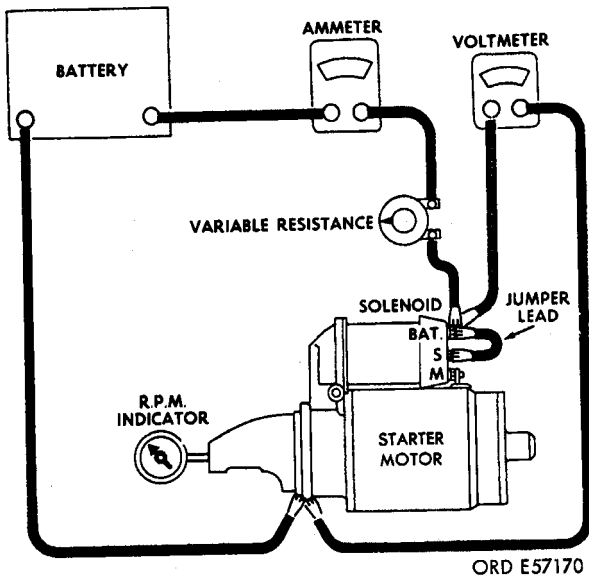


FIGURE 40. NO-LOAD TEST WIRING DIAGRAM.

- (1) Connect a 24-volt battery in series with an ammeter and variable resistance to the battery terminal of the solenoid.

For the return circuit, connect a lead from the frame of the starter to the battery. Connect a voltmeter from the solenoid "BAT" terminal to ground. Energize the solenoid by connecting a jumper lead from the solenoid battery terminal to the solenoid switch terminal. Check the rotation speed of the armature with a tachometer. Obtain the specified voltage (23.0 volts) by varying the resistance unit. Minimum speed should be 7000 rpm. Check the current draw on the ammeter. Maximum current draw should be 90 amperes.

- (2) If a low speed, high current condition exists, check the armature for excessive arching, grounds, and shorts (par. 26d). Examine starter for armature drag. If drag exists, check for loose pole shoe screws (fig. 18) and tighten as necessary. Check for armature eccentricity (par. 26d) or faulty bearings.
- (3) If a low speed, low current condition exists, inspect the starter for faulty connections and for poor brush contact (fig. 35).

b. Lock-Torque Test. DELETED

### 39. Waterproof Test

a. Connect an air line to the frame of the starter. The connection must be air tight.

b. Submerge the starter in the clean water up to the drive housing and clutch assembly area. Do not allow water to enter the drive housing and clutch area. Apply air pressure slowly. Watch for air bubbles. Increase pressure to 6 psi.

c. With air pressure remaining at 6 psi, allow starter to remain submerged for 30 minutes. No leaks should be indicated during this period.

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

## Section VI. REPAIR STANDARDS

### 40. General

The repair standards included herein give maximum and minimum clearances of new or rebuilt parts. They also give wear limits which indicate that point to which a part or parts may be worn before replacement. Normally, all parts which have not been worn beyond the dimensions shown in the "Direct and general support wear limits" column or damaged from

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



## 41. Wear Limits

| Fig. no.                                       | Reference letter | Point of measurement                                       | Sizes and fits of new parts | Direct and general support wear limits |
|--|------------------|--|-----------------------------|--|
| <i>a. Brushes and Springs.</i>                 |                  |  |                             |  |
| 10 (Step 2)                                    | C                | Brush length   | 0.7500 to 0.7600            | 0.3750                                 |
| 10 (Step 1)                                    |                  | Brush spring tension                                       | 80 oz.                      |  |
| <i>b. Thrust Washers and Spacers.</i>          |                  |  |                             |  |
| 6 (Step 3)                                     | D                | Thrust washer thickness (Commutator end of armature shaft) | 0.0590 to 0.0650            |  |
| 6 (Step 3)                                     | C                | Spacer thickness (Drive end of armature shaft)             | 0.1800 to 0.1960            |  |
|  |                  | Maximum end play of armature                               | 0.0050                      | 0.0050                                 |
| <i>c. Solenoid Plunger Compression Spring.</i> |                  |  |                             |  |
| 12   | C                | Free length  | 2.7920                      |  |
|  | C                | Solid length   | 0.6510                      |  |
|  | C                | Load at 1.56 inches length                                 | 13.5 to 14.5 lbs.           |  |
| <i>d. Sleeve Bearings.</i>                     |                  |  |                             |  |
| 63   | d                | Commutator end plate sleeve bearing inside diameter        | 0.5625 to 0.5635            |  |
| 63   | e                | Armature shaft diameter at commutator end                  | 0.5590 to 0.5610            |  |
| 63   | e-d              | Fit of shaft in bearing                                    | 0.0015L to 0.0045L          | 0.0090L                                |
| 10   | A                | Commutator end plate bore                                  | 0.7490 to 0.7500            |  |
| 10   | N                | Commutator end plate sleeve bearing outside diameter       | 0.7550 to 0.7570            |  |
| 10   | N-A              | Fit of bearing in end plate                                | 0.0050T to 0.0080T          |  |
| 63   | c                | Lever housing sleeve bearing inside diameter               | 0.8335 to 0.8355            |  |
| 63   | f                | Armature shaft diameter                                    | 0.8225 to 0.8240            |  |
| 63   | f-c              | Fit of shaft in bearing                                    | 0.0095L to 0.0130L          | 0.0260L                                |
| 14   | F                | Lever Housing bore   | 0.9570 to 0.9580            |  |
| 14   | G                | Lever housing sleeve bearing outside diameter              | 0.9630 to 0.9650            |  |
| 14   | G-F              | Fit of bearing in housing                                  | 0.0050T to 0.0080T          |  |
| 63   | a                | Drive housing sleeve bearing inside diameter               | 0.6240 to 0.6260            |  |
| 63   | h                | Armature shaft diameter (Drive end)                        | 0.6220 to 0.6230            |  |
| 63   | h-a              | Fit of shaft in bearing                                    | 0.0010L to 0.0040L          | 0.0080L                                |
| 9  | B                | Drive housing bore   | 0.7490 to 0.7500            |  |
| 9  | C                | Drive housing sleeve bearing outside diameter              | 0.7550 to 0.7570            |  |
| 9  | B-C              | Fit of bearing in housing                                  | 0.0050T to 0.0080T          |  |
| 63   | b                | Drive clutch sleeve bearing inside diameter                | 0.6245 to 0.6260            |  |
| 63   | g                | Armature shaft diameter (Drive end)                        | 0.6220 to 0.6230            |  |

| Fig. no.                                   | Reference letter | Point of measurement   | Sizes and fits of new parts | Direct and general support wear limits |
|--|------------------|--|-----------------------------|--|
| <i>d. Sleeve Bearings — Continued.</i>     |                  |  |                             |  |
| 63   | g-b              | Fit of shaft in bearing  | 0.0015L to 0.0040L          | 0.0080L                                |
| 16 (Step 3)                                | B                | Drive clutch sleeve bore   | 0.6870 to 0.6880            |  |
| 16 (Step 3)                                | G                | Drive clutch sleeve bearing outside diameter                       | 0.6930 to 0.6950            | *                                      |
| 16 (Step 3)                                | G-B              | Fit of bearing in sleeve   | 0.0050T to 0.0080T          |  |
| <i>e. Commutator.</i>                      |                  |  |                             |  |
| 24   |                  | Commutator diameter  | 2.1150 to 2.1250            |  |
| 24   |                  | Commutator minimum turned diameter                                 |                             | 2.000                                  |
| 22   |                  | Commutator diameter T.I.R. runout with shaft diameters at bearings | 0.0020                      |  |
| <i>f. Drive Clutch Compression Spring.</i> |                  |  |                             |  |
| 15   | C                | Compression spring free length                                     | 1.6760                      |  |
| 15   | C                | Compression spring solid length                                    | 0.7090                      |  |
| 15   | C                | Spring load at 1.312 inches length                                 | 7 to 9 lbs                  |  |
| 15   | C                | Spring load at 0.750 inches length                                 | 19 to 21 lbs                |  |

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**STARTER, ENGINE ELECTRICAL ASSEMBLY-  
(DELCO-REMY MODELS, 1113904 AND 1113944)**

**End Item Application**

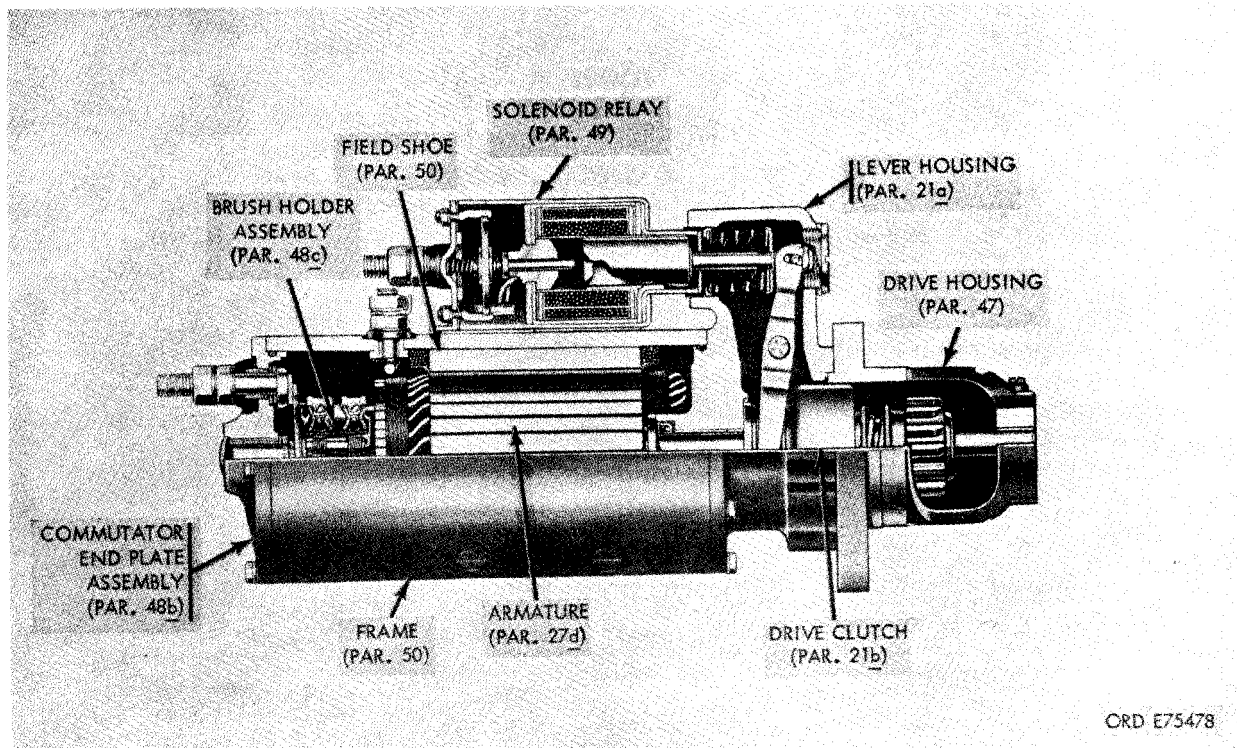
**ENGINE, DIESEL, MULTIFUEL, TURBOCHARGED, 6-CYLINDER  
(MILITARY MODEL LDS-465-1A)**

**ENGINE, DIESEL, MULTIFUEL, 6-CYLINDER  
(MILITARY MODEL LD-465-1)**

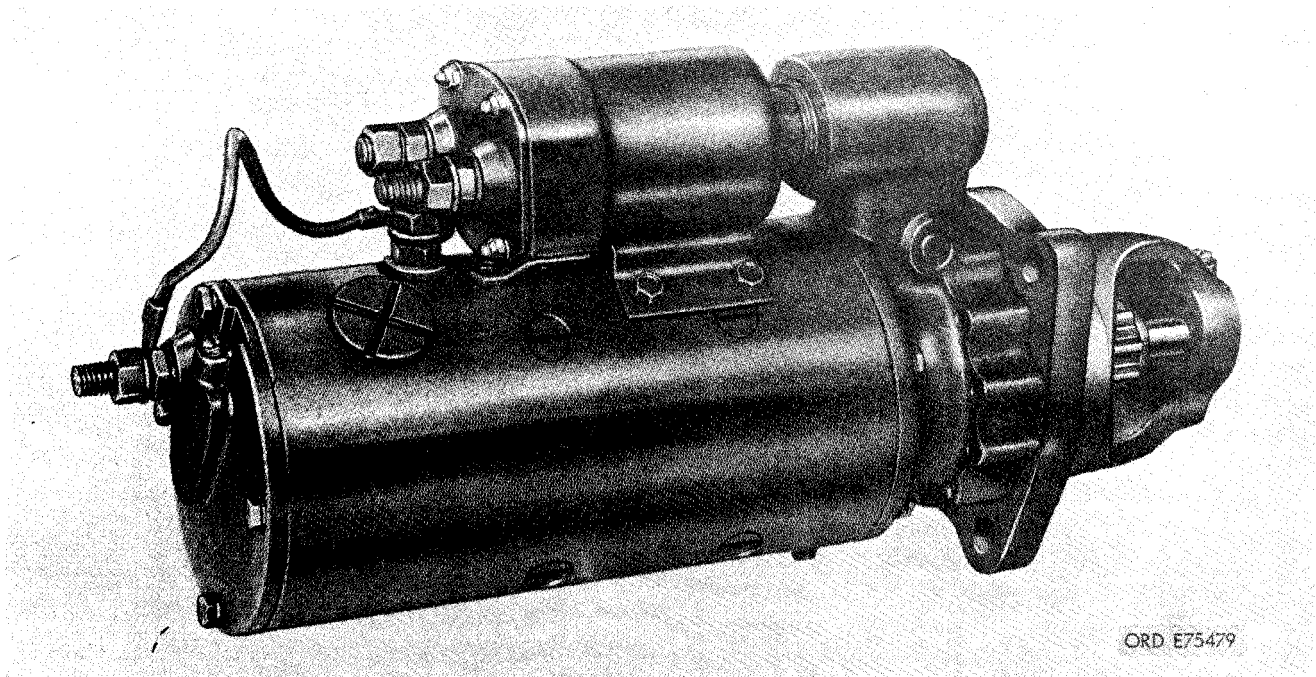
**ENGINE ASSEMBLY W/ACCESSORIES  
MACK DIESEL MODEL ENDT-673**

**ENGINE DIESEL W/ACCESSORIES  
CUMMINS MODEL V8-300**

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*Figure 51. Starter assembly-typical assembled view.*



## CHAPTER 5 INTRODUCTION

### Section I. GENERAL

#### 42. Scope

a. The procedures covered in this change will apply only to those models listed on the title page of this change (page 47). Because of earlier erroneous identification, it is suggested the reader firmly fix in his mind the fact that the basic manual should have been labeled Delco-Remy 1113904-B and not 1113904 as indicated on basic manual.

b. The starters covered in this change are improved models incorporating new armatures and solenoid relays. Although the starters differ internally from the earlier models, they are all to be replaced by military model 10911018-1 (para 43, below).

#### 43. Differences Between Models

a. Military part No. 10911018-1 was originally assigned to Delco-Remy Model 1113904-B starter. Improvements were made to this model and it was

later designated as Delco-Remy model 1113943, and still identified as military part No. 10911018-1. The nose housing on these two models are indexed to 37 degrees 30 minutes for the Mack ENDT-673 and LDS-465-1A engines, and 52 degrees 30 minutes for the LDS-465-1 engine.

b. Military part No. 10911018 identifies Delco-Remy Model 1113904 starter. This starter is similar to Delco-Remy model 1113943 except for the nose housing which is indexed 82 degrees, 30 minutes clockwise of the solenoid relay. This starter is used on engine model LD-465-1.

c. Military part No. 10911018-1 also identifies Delco-Remy model 1113944. This starter is similar to models 1113904 and 1113943 except that the pinion gear contains one blank tooth. This starter is used on engine model V8-300 only. The nose housing is indexed at 47 degrees, 30 minutes clockwise of the solenoid relay.

### Section II. DESCRIPTION AND DATA

#### 44. Description

Refer to paragraph 4 for description of starter, part No. 10911018 and 10911018-1.

#### 45. Data

Refer to paragraph 5 for tabulated data on starter, part No. 10911018 and 10911018-1.





CHAPTER 6  
PARTS, SPECIAL TOOLS, AND EQUIPMENT

---

Refer to chapter 2 for parts, special tools, and equipment.



## CHAPTER 7 TROUBLESHOOTING

---

Refer to chapter 3 for troubleshooting procedures.



## CHAPTER 8 REPAIR

### Section I. DISASSEMBLY

#### 46. Disassembly into Subassemblies

Refer to paragraph 18 and disassemble starter into subassemblies.

#### 47. Disassembly of Drive Housing

Refer to figure 52 and disassemble drive housing.

#### 48. Disassembly of Commutator End Plate Assembly

a. Refer to figure 53 and disassemble the commutator end plate assembly.

b. Refer to figure 11 and disassemble the brush holder assembly.

#### 49. Disassembly of Lever Housing and Drive Clutch Assembly

a. *Disassembly of Lever Housing.*

(1) Refer to figures 12 and 13 for removing solenoid plunger, shift lever, and shaft from the lever housing.

(2) Refer to figure 54 for disassembly of lever housing.

b. *Disassembly of Drive Clutch Assembly.* Disassemble the drive clutch assembly as shown in figures 15 and 16.

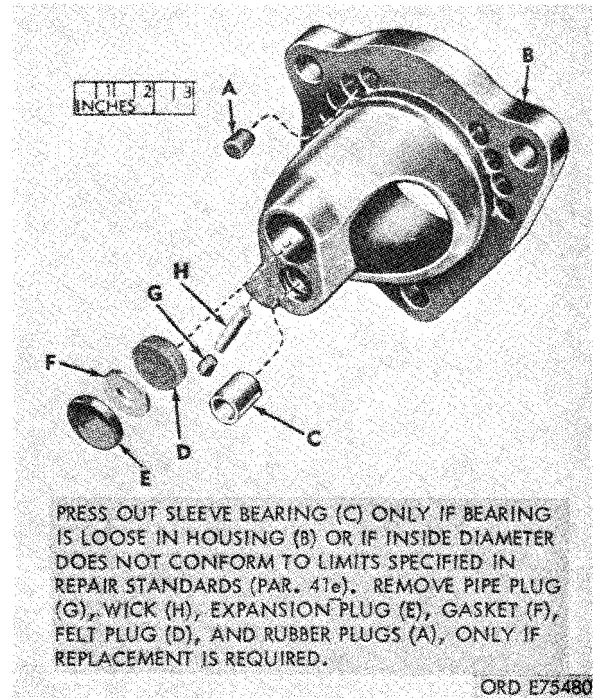
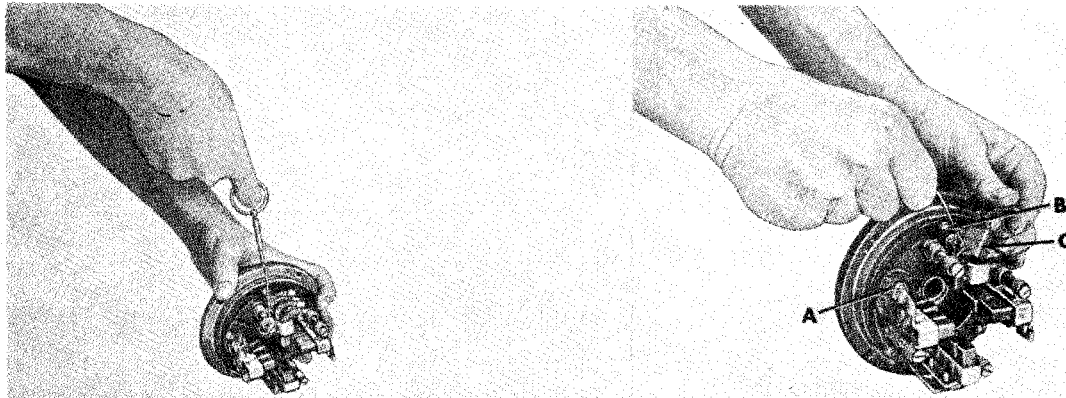
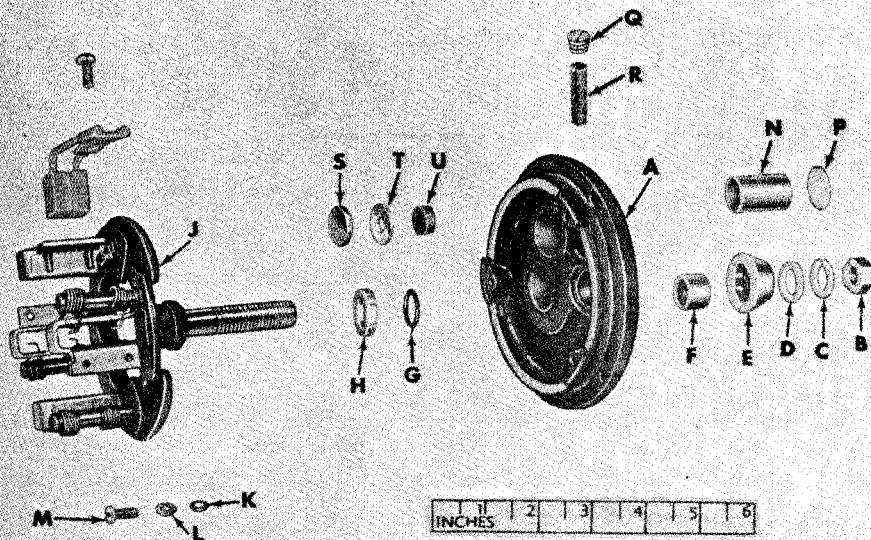


Figure 52. Disassembling drive housing assembly.



**STEP 1.** TEST BRUSH SPRING TENSION. TENSION MUST BE WITHIN LIMITS SPECIFIED IN REPAIR STANDARDS (PAR. 41a). REPLACE ENTIRE SET OF SPRINGS IF ANY ARE NOT WITHIN LIMITS SPECIFIED.

**STEP 2.** MARK LOCATION OF BRUSHES. REMOVE EIGHT NO. 8 x 7/16 INCH LONG FILLISTER HEAD SCREWS (A). LIFT BRUSH SPRING WITH BRUSH SPRING LIFTER (B) (SEE FIGURE 3) AND REMOVE BRUSH (C). REPEAT UNTIL EIGHT BRUSHES ARE REMOVED.



**STEP 3.** REMOVE HEX NUT (B), LOCK WASHER (C), AND FLAT WASHER (D), FROM TERMINAL STUD. REMOVE THREE PAN HEAD SCREWS (M), LOCK WASHERS (L), AND FLAT WASHERS (K), AND SEPARATE BRUSH HOLDER ASSEMBLY (J) FROM COMMUTATOR END PLATE (A). REMOVE RUBBER BUSHING (G), AND WASHER (H) FROM TERMINAL STUD. REMOVE BUSHING (F) AND TERMINAL STUD INSULATOR (E) FROM COMMUTATOR END PLATE.

**STEP 4.** PRESS OUT SLEEVE BEARING (N) AND EXPANSION PLUG (P) ONLY IF BEARING IS LOOSE IN END PLATE (A) OR IF INSIDE DIAMETER DOES NOT CONFORM TO LIMITS SPECIFIED IN REPAIR STANDARDS (PAR. 41e). REMOVE PIPE PLUG (Q), WICK (R), EXPANSION PLUG (S), GASKET (T), AND FELT PLUG (U).

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Figure 53. Disassembling commutator end plate assembly.

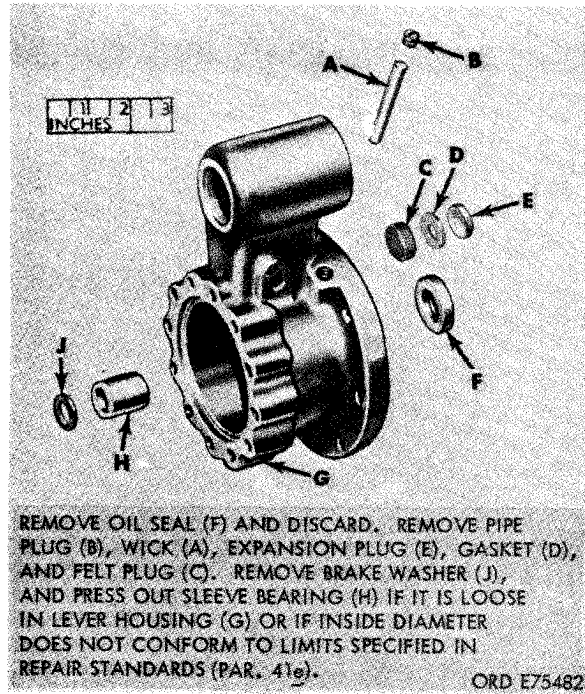


Figure 54. Disassembling lever housing.



### 50. Disassembly of Solenoid Relay

Refer to figure 55 and disassemble the solenoid relay.

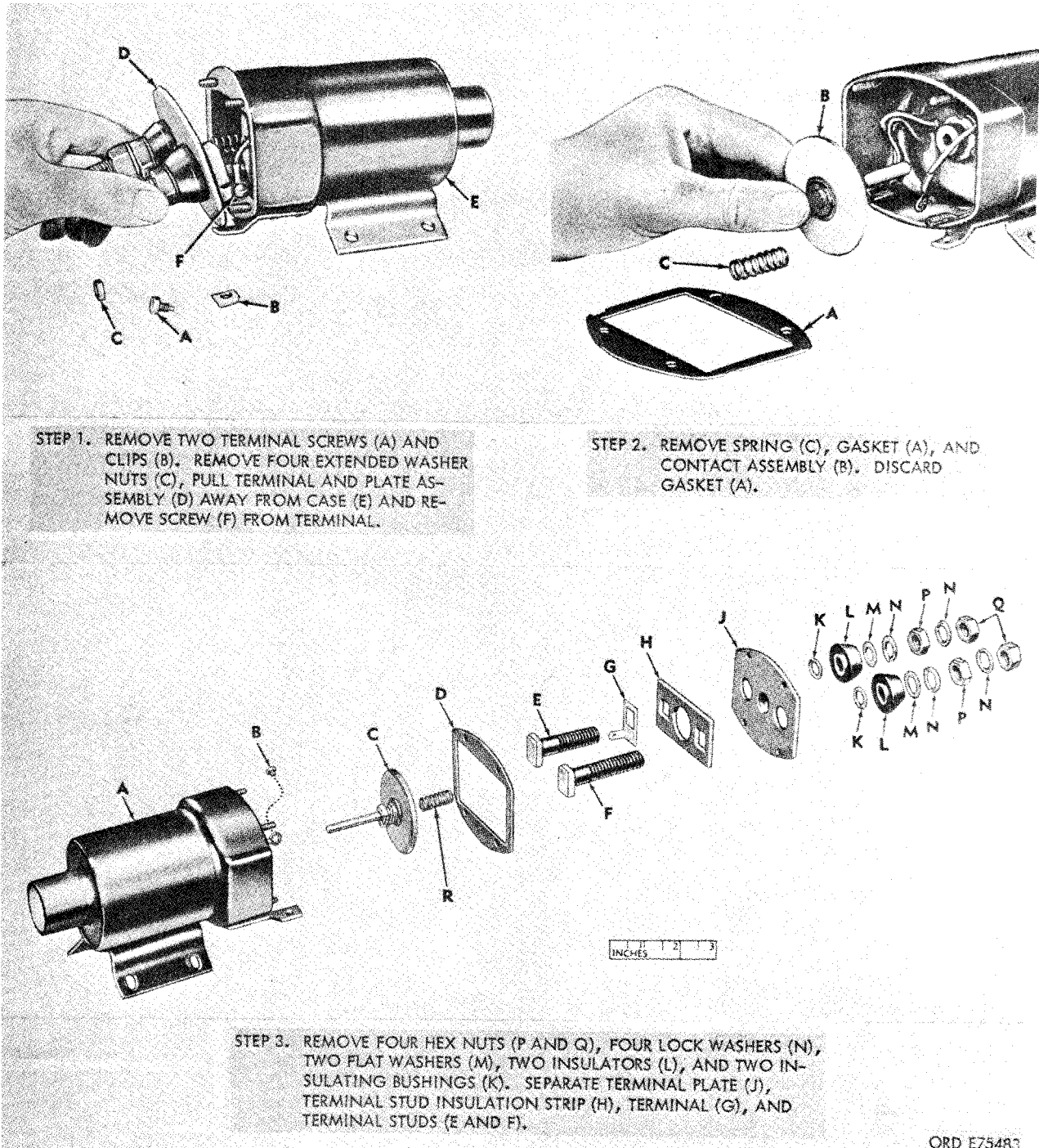


Figure 55. Disassembling solenoid relay.

**51. Disassembly of Frame Assembly**

Refer to figures 56 and 57 and disassemble the frame assembly.

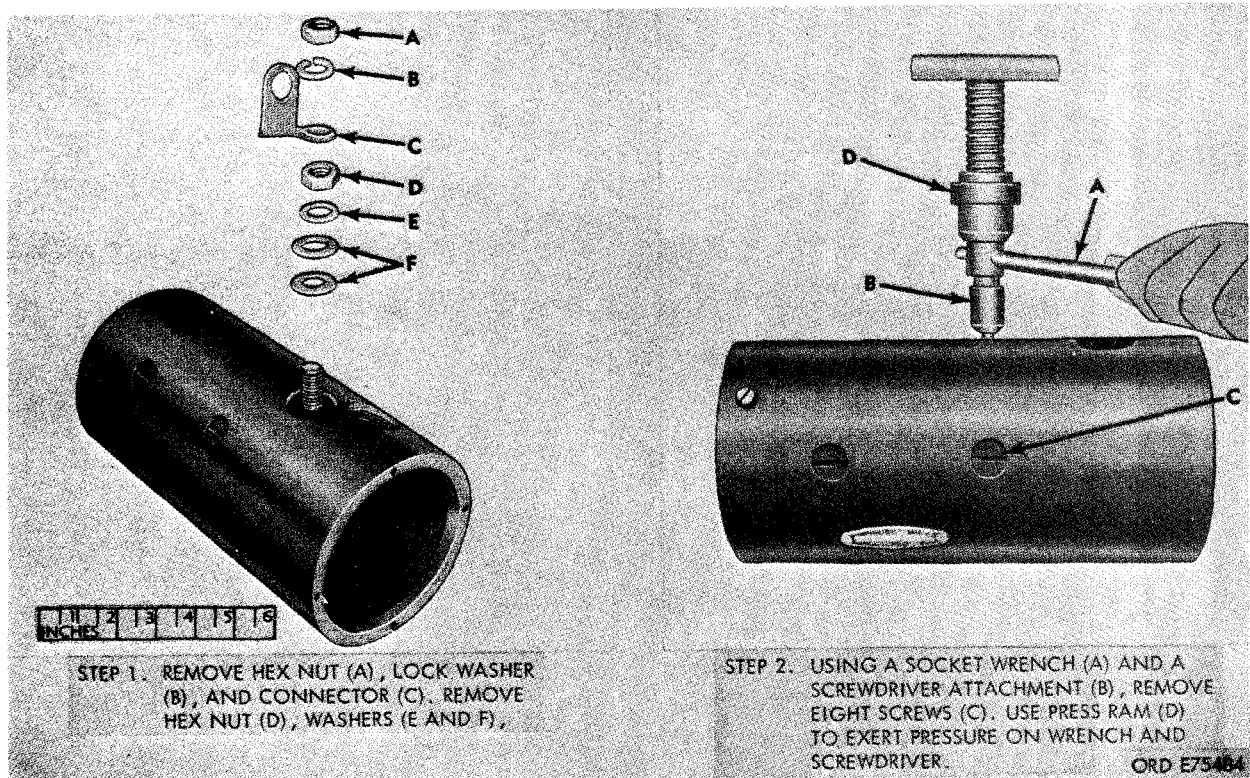


Figure 56. Removing field coils.

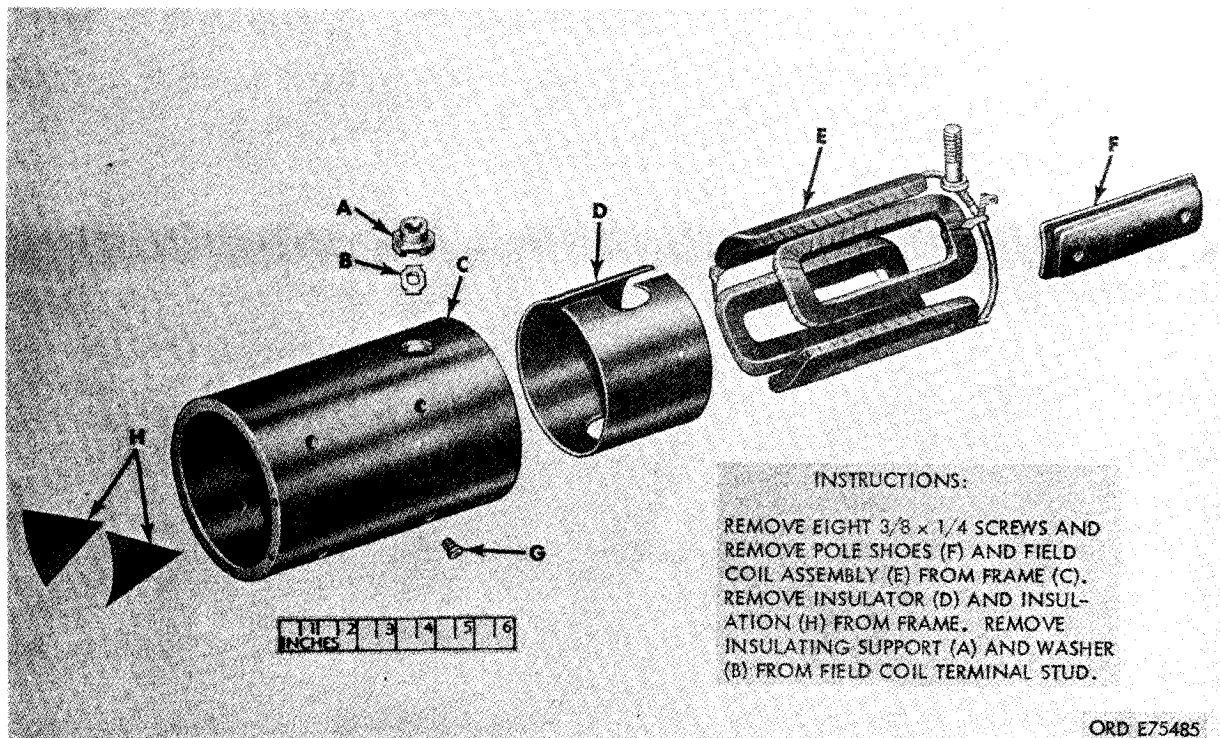


Figure 57. Field coils separated from frame.

## Section II. ASSEMBLY

### 52. Assembly of Frame Assembly

*Note.* The key letters shown below in parentheses refer to figure 57 except where otherwise indicated.

*a.* Install washer (B) and support, (A) on field coil terminal stud and position field coil (E) in frame (C). Install insulator (D) and two insulations (H) between frame and field coils.

*b.* Position each of four pole shoes (F), in turn, on coil inside frame. Align mating holes and secure each pole with two pole shoe screws (G) (2, fig. 56). Coat threads of pole shoe screws with a suitable thread sealer before installation.

*Note.* The key letters shown below in parentheses refer to figure 56.

*c.* Install two nonmetallic washers (F), 0.520 ID., 7/8 OD., 0.031 thick flat washer (E), 1/2-inch hex nut (D), field coil terminal-to-solenoid relay connector (C), 1/2-inch lockwasher (B), and 1/2-inch hex nut (A).

*d.* Varnish inside of frame and coil assembly. Leave 0.38 inch from each end of frame free of varnish. Allow varnish to dry thoroughly before assembling starter.

### 53. Assembly of Solenoid Relay

*Note.* The key letters shown below in parentheses refer to figure 55, step 3, except where otherwise indicated.

*a.* Install terminal (G) on motor terminal stud (E) (short stud). Install motor terminal stud, battery terminal stud (F), terminal stud insulation strip (H), and terminal plate (J) with motor terminal stud in plate marked MOTOR. Install one insulating bushing (K), one insulator (L), one 0.516 ID., 7/8 OD., 1/32 thick flat washer (M), 1/2-inch lockwasher (N), 1/2-inch, 0.312 thick hex nut (P), 1/2-inch lockwasher (N) and 1/2-inch, 0.438 thick hex nut (Q) on each terminal stud.

*b.* Refer to figure 58 and complete assembly of solenoid relay.

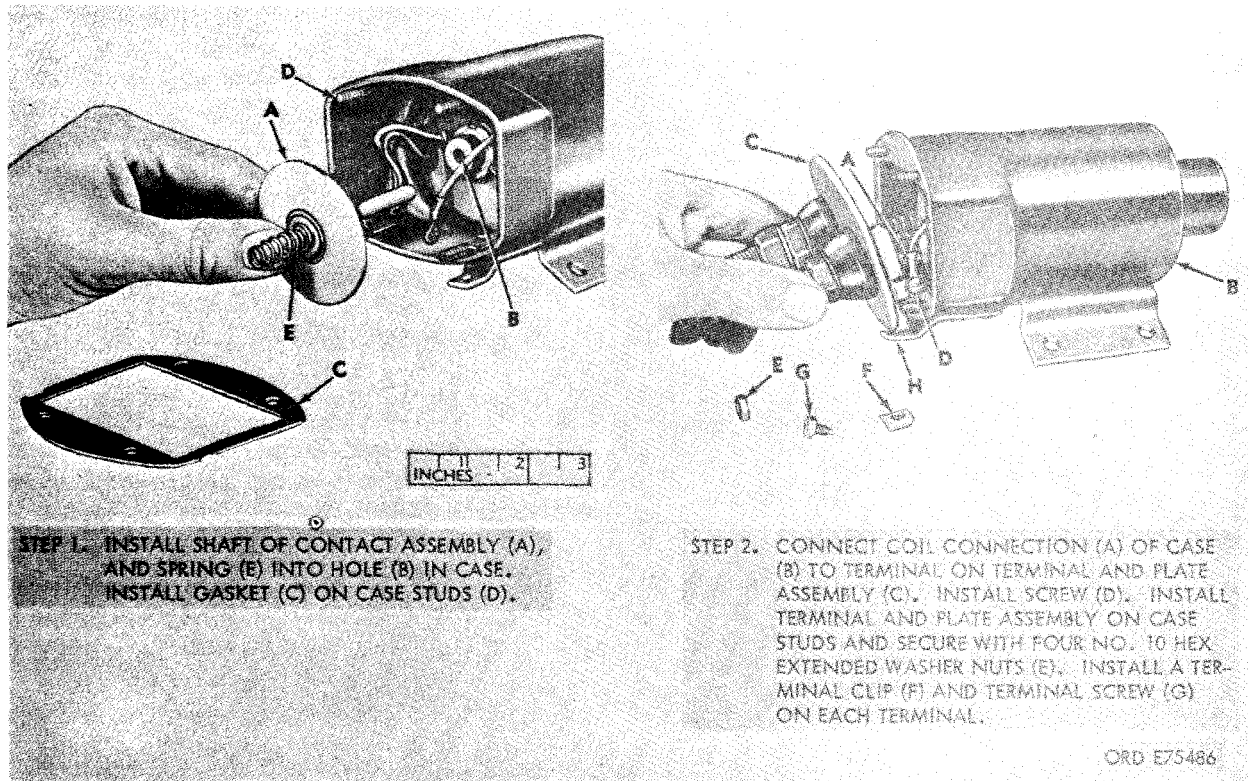


Figure 58. Assembling solenoid relay.

#### 54. Assembly of Drive Clutch and Lever Housing

a. *Assembly of Drive Clutch.* Refer to paragraph 32a and figures 29 and 30.

b. *Assembly of Lever Housing.* Refer to figure 54.

- (1) Install sleeve bearing (H) in lever housing (G). Ream sleeve bearing bore to limits specified in wear limits (para 41c). Install brake washer (J).
- (2) Saturate wick (A) and felt plug (C) with oil (OE). Apply sealer to expansion plug seat. Install felt plug (C), gasket (D), and expansion plug (E). Install wick (A) and fill reservoir with oil (OE) and install pipe plug (B).
- (3) Apply sealer to oil seal counterbore and install new oil seal (F).

c. *Assembly of Solenoid Plunger and Lever.* Refer to figure 31 and install solenoid plunger and lever in lever housing.

#### 55. Assembly of Commutator End Plate Assembly

a. *Assembly of Brush Holder Assembly.* Refer to paragraph 33a and figure 11 and assemble the brush holder assembly.

b. *Assembly of Commutator End Plate.* Refer to figure 53 and assemble the commutator end plate as follows:

- (1) Install a new bearing (N, step 4) in commutator end plate (A). Drill oilhole and ream sleeve bearing bore to limits specified in wear limits (para 41e).
- (2) Saturate wick (R, step 4) and felt plug (U) with oil (OE).
- (3) Apply sealer to expansion plug seat. Install felt plug (U, step 4), gasket (T), and expansion plug (S).
- (4) Install wick (R, step 4) and fill reservoir with oil, and install pipe plug (Q).

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- (5) Install 0.516-inch ID nonmetallic washer (H, step 3) and rubber bushing (G) on terminal stud of brush holder assembly (J).
- (6) Install brush holder assembly (J) in commutator end plate (A), and secure with three No. 8 by 1/2-inch pan head screws (M), lockwashers (L), and flat washers (K).
- (7) Install bushing (F, step 3), terminal stud insulator (E), 0.520-inch ID flat washer (D), 1/2-inch lockwasher (C), and 1/2-inch, 0.310-inch thick hex nut (B).

**56. Assembly of Drive Housing**

Refer to figure 52 and assemble drive housing as follows:

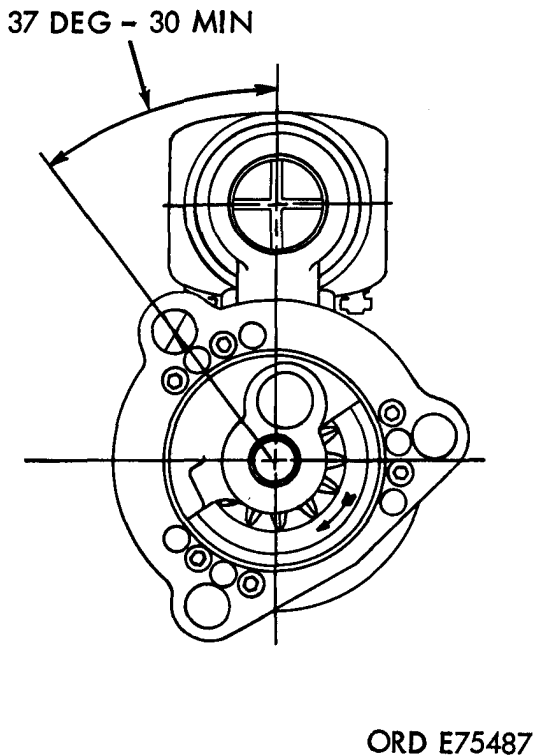


Figure 59. Drive housing position—model ENDT-673 engine application.

- a. Install new sleeve bearing (C) in drive housing (B). Drill oilhole and ream sleeve bearing bore to limits specified in wear limits (para 41e).
- b. Saturate wick (H), and felt plug (D) with oil (OE).
- c. Apply sealer to expansion plug seat. Install felt plug (D), gasket (F), and expansion plug (E).
- d. Install wick (H) and fill reservoir with oil (OE), and install pipe plug (G).
- e. Install rubber plugs (A) in housing (B).

**57. Assembly of Starter Assembly**

Refer to paragraph 35 for assembly for starter assembly except refer to figures 59 through 62 when indexing the drive housing.

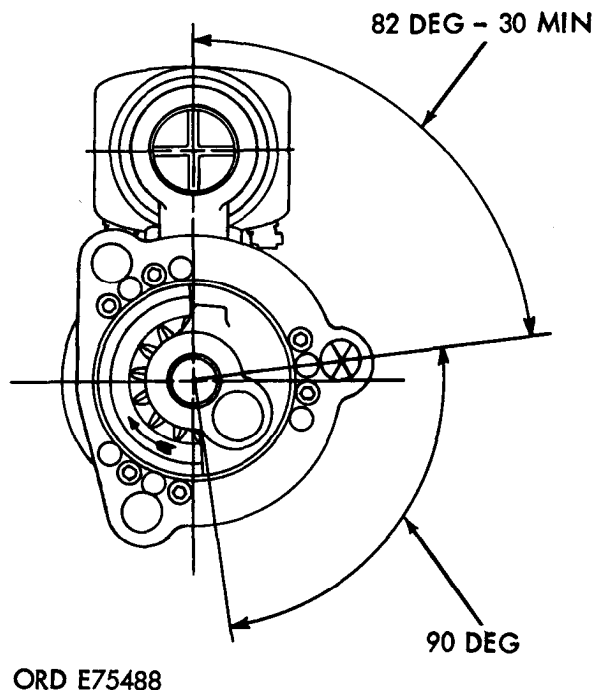


Figure 60. Pinion housing position—model LD-465-1 engine application.

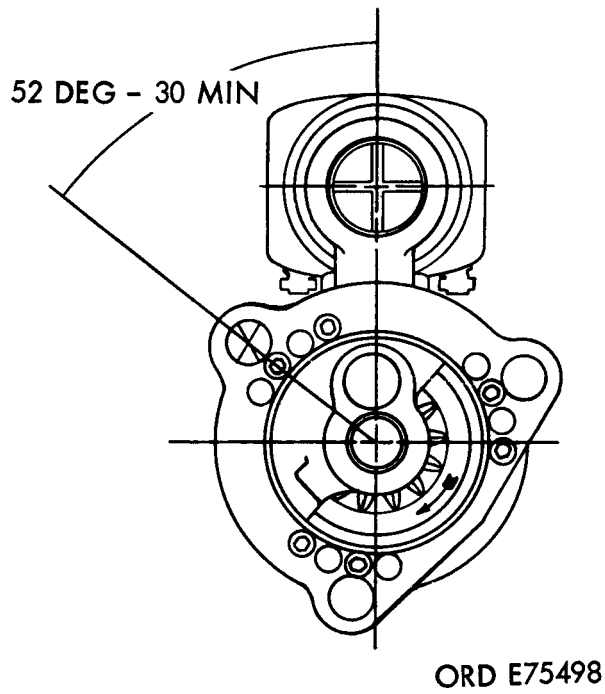


Figure 61. Drive housing position—model LDS-465-1 and LDS-465-1A engine application.

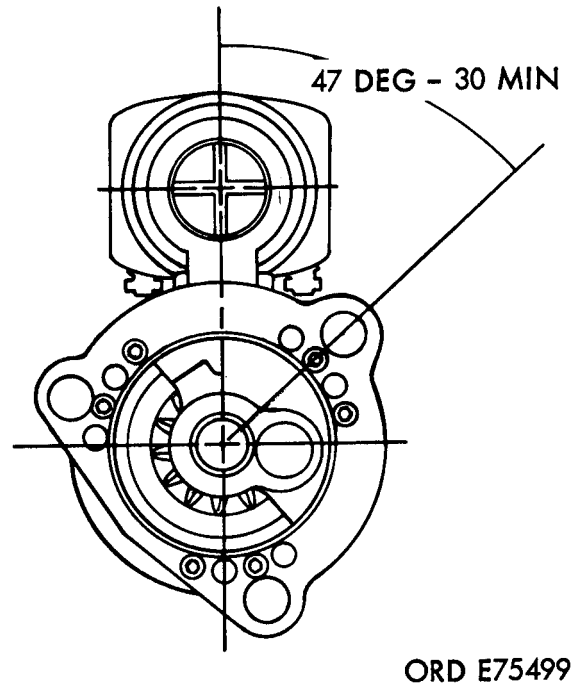


Figure 62. Drive housing position—model V8-300 engine application.

### Section III. REPAIR STANDARDS

#### 58. General

Refer to paragraph 40.

#### 59. Wear Limits

Refer to paragraph 41.



## APPENDIX I REFERENCES

---

### 1. Publication 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 material covered in this manual.

|   |              |
|---|--------------|
| Index of Army Motion Pictures, Film Strips, Slides, Tapes, and Phono-Recordings . . . . .   | DA Pam 108-1 |
| Military Publications:  |              |
| Index of Administrative Publications . . . . .  | DA Pam 310-1 |
| Index of Blank Forms . . . . .  | DA Pam310-2  |
| Index of Doctrinal, Training, and Organizational Publications. . . . .  | DA Pam 310-3 |
| Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 7, 8, and 9),<br>Supply Bulletins, Lubrication Orders, and Modification Work Orders. | DA Pam 310-4 |
| Index of Graphic Aids and Devices . . . . .   | DA Pam 310-5 |
| Index of Supply Catalogs and Supply Manuals (Excluding Types 7, 8, and 9) . . . . .   | DA Pam 310-6 |

### 2. Publication Reference

The following publication is referenced within this manual:

|                     |                                  |
|---------------------|----------------------------------|
| TM 38-750 . . . . . | Army Equipment Record Procedures |
|---------------------|----------------------------------|





# APPENDIX II

## DIRECT AND GENERAL SUPPORT MAINTENANCE REPAIR PARTS

### Section I. INTRODUCTION

#### 1. Scope

This appendix lists repair parts required for the performance of direct and general support of the Delco-Remy Engine Electrical Starter Assemblies, Models 1113943, 1113904, and 1113944.

#### 2. General

This Repair Parts List is divided into the following sections:

*a. Repair Parts - Section II.* A list of repair parts authorized for the performance of maintenance at the direct and general support level in figure and item number sequence.

*b. Special Tools, Test and Support Equipment.* Not applicable.

*c. Federal Stock Number and Reference Number Index - Section III.* A list of Federal stock numbers in ascending numerical sequence followed by a list of reference numbers in ascending alpha-numeric sequence, cross-referenced to the illustration figure number and item number.

#### 3. Explanation of Columns

The following provides an explanation of columns in the tabular lists in Sections II and III.

*a. Source, Maintenance, and Recoverability Codes (SMR), Column 1:*

(1) Source code, indicates the selection status and source for the listed item. Source codes used are —

| <i>Code</i> | <i>Explanation</i>   |
|-------------|--|
| P           | Repair Parts, Special Tools and Test Equipment supplied from the GSA/DSA, or Army supply system, and authorized for use at indicated maintenance categories.   |
| P2          | Repair Parts, Special Tools and Test Equipment which are procured and stocked for insurance purposes because the combat or military essentiality of the end item dictates that a minimum quantity be available in the supply system. |
| P9          | Assigned to items which are NSA design controlled: unique repair parts, special tools, test, measuring and diagnostic equipment, which are stocked and supplied by the Army COMSEC Logistic System and which                         |

| <i>Code</i> | <i>Explanation</i>  |
|-------------|---|
|             | are not subject to the provisions of AR 380-41.   |
| P10         | Assigned to items which are NSA design controlled: special tools, test, measuring and diagnostic equipment for COMSEC support, which are accountable under the provisions of AR 380-41, and which are stocked and supplied by the Army COMSEC Logistic System.  |
| M           | Repair Parts, Special Tools and Test Equipment which are not procured or stocked, as such, in the supply system but are to be manufactured at indicated maintenance levels.   |
| A           | Assemblies which are not procured or stocked as such, but are made up of two or more units. Such component units carry individual stock numbers and descriptions, are procured and stocked separately and can be assembled to form the required assembly at indicated maintenance categories.   |
| X           | Parts and assemblies that are not procured or stocked because the failure rate is normally below that of the applicable end item of component. The failure of such part or assembly should result in retirement of the end item from the supply system.   |
| X1          | Repair Parts which are not procured or stocked. The requirement for such items will be filled by the next higher assembly or component.   |
| X2          | Repair Parts, Special Tools, and Test Equipment which are not stocked and have no foreseen mortality. The indicated maintenance category requiring such repair parts will attempt to obtain the parts through cannibalization or salvage, if not obtainable through cannibalization or salvage the item may be requisitioned with exception data, from the end item manager, for immediate use. |
| G           | Major assemblies that are procured with PEMA funds for initial issue only as exchange assemblies at DSU and GSU level. These assemblies will not be stocked above the DS and GS level or returned to depot supply level.  |

#### NOTE

Cannibalization or salvage may be used as a source of supply for any items source coded above, except those coded X1.

(2) Maintenance Code, indicates the lowest category of maintenance authorized to install the listed item. The maintenance level codes are-

| <i>Code</i> | <i>Explanation</i>           |
|-------------|------------------------------|
| C           | Crew or Operator Maintenance |

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| <i>Code</i> | <i>Explanation</i>           |
|-------------|------------------------------|
| O           | Organization Maintenance.    |
| F           | Direct Support Maintenance.  |
| H           | General Support Maintenance. |
| D           | Depot Maintenance.           |

(3) Recoverability Code, indicates whether unserviceable items should be returned for recovery or salvage. Recoverability Codes are –

| <i>Code</i> | <i>Explanation</i>   |
|-------------|--|
| R           | Applied to repair parts, (assemblies and components), special tools, and test equipment which are considered economically repairable at direct and general support maintenance levels. When the item is no longer economically repairable, it is normally disposed of at the GS level. When supply considerations dictate, some of these repair parts may be listed for automatic return to supply for depot level repair as set forth in AR 710-50. When so listed, they will be replaced by supply on an exchange basis. |
| S           | Repair Parts, Special Tools, Test Equipment and assemblies which are economically repairable at DSU and GSU activities and which normally are furnished by supply on an exchange basis. When items are determined by a GSU to be uneconomically repairable, they will be evacuated to a depot for evaluation and analysis before final disposition.  |
| T           | Higher dollar value recoverable repair parts, special tools and test equipment which are subject to special handling and are issued on an exchange basis. Such items will be evacuated to the depot for overhaul or final disposition, Communications - Electronics and Missile Support Items will be repaired/overhauled only at depots.  |
| U           | Repair Parts, Special Tools and Test Equipment specifically selected for salvage by reclamation units because of precious metal content, critical materials, high dollar value or reusable casings or castings.  |

**NOTE**

When no code is indicated in the recoverability column, the part will be considered non-recoverable.

*b. Federal Stock Number, Column 2.* This column indicates the Federal stock number assigned to the item and will be used for requisitioning purposes.

*c. Description, Column 3.* This column indicates the Federal item name and any additional description of the item required. A part number or other reference number is followed by the applicable five-digit Federal supply code for manufacturers in parentheses. Repair parts quantities included in the kits, sets, and assemblies are shown in front of the repair part name.

*d. Unit of Measure (U/M), Column 4.* A two character alphabetic abbreviation indicating the

amount or quantity of the item upon which the allowances are based, e.g., ft, ea, pr, etc.

*e. Quantity Incorporated in Unit, Column 5.* This column indicates the quantity of the item used in the functional group. A “V” appearing in this column in lieu of a quantity indicates that a definite quantity cannot be indicated (e.g., shims, spacers, etc.).

*f. 30-Day DS/GS Maintenance Authorization, Columns 6, and 7*

(1) The Repair Parts List includes asterisk entries in separate columns - one for Direct Support (DS) and one for General Support (GS) - as appropriate to indicate the total range of repair parts authorized for use at that category or required to be removed or disassembled during the performance of authorized maintenance operations. They will be requisitioned initially on an “as required” basis. The repair parts authorized at the DS/GS levels will be those authorized for the maintenance mission at these levels. Requirements for repair part stockage and for distribution to supported units will be based on demand and determined in accordance with AR 711-16.

(2) Special Tools or Test, Measurement and Diagnostic Equipment (TMDE) and other support equipment peculiar to an item are listed with quantities in the appropriate density spread/allowance columns. (Not applicable).

*g. 1-Year Allowances Per 100 Equipments/Contingency Planning Purposes, Column 8.* This column indicates the total requirement for contingency planning purposes. An asterisk indicates authorization to obtain or use as required.

*h. Depot Maintenance Allowance Per 100 Equipments, Column 9.* This column indicates authorization for depot use.

*i. Illustration, Column 10.* This column is divided as follows:

(1) *Figure number, Column 10a.* Indicates the figure number of the illustration in which the item is shown.

(2) *Item number, Column 10b.* Indicates the callout number used to reference the item in the illustration.

### 3-1. Explanation of Columns

The following provides an explanation of columns found in the tabular listings of this change.

#### a. Source, Maintenance and Recoverability Codes (SMR), Column 1.

(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:

| Code | Definition  |
|------|---|
| PA   | Item procured and stocked for anticipated or known usage.   |
| PB   | Item procured and stocked for insurance purposes 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 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.  |
| XA   | Item is not procured or stocked because the requirements  |

| Code | Definition  |
|------|---|
|      | 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 maybe used as a source of supply for any items coded above except those coded XA.

(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 positions of the Uniform SMR Code format as follows:

**USE (THIRD POSITION):** 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.

| Code | Application/Explanation  |
|------|--|
| 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. |

**REPAIR (FOURTH POSITION):** 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 as assigned by the service(s) that require the code:

| Code | Definition   |
|------|--|
| 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 (enter applicable activity) Depot, Mobile Depot or Specialized Repair Activity. |

| Code | Application/Explanation  |
|------|--|
| L    | Repair restricted to designed Specialized Repair Activity.   |
| Z    | Non-repairable. No repair is authorized.   |
| B    | No repair is authorized. The item maybe reconditioned by adjusting, lubrication, etc., at the user level. No parts or 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:

| Code | Definition   |
|------|--|
| Z    | Nonrepairable 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. |

#### 4. Special Information

a. Identification of the usable on codes included in column 3 of this publication are:

| Code | Used on  |
|------|--|
| A    | Starter, Engine Electrical, Delco-Remy Model 1113943 |
| B    | Starter, Engine Electrical, Delco-Remy Model 1113904 |
| C    | Starter, Engine Electrical, Delco-Remy Model 1113944 |

b. Applicable publications are:

- TM 9-2320-206 . . .Truck, Cargo, 10 Ton 6x6 (M125)
- TM 9-2320-211 . . .Truck, Cargo, 5 Ton 6x6 (M41, M54, M55)
- TM 9-2320-230 . . .Truck, Cargo, 5 Ton 8x8 (M656)
- TM 9-2815-210 . . .DS/GS and depot maintenance manual: Engine (multifuel), (LDS 465-1 and LDS 465-1A)
- TM 9-2815-207 . . .DS/GS maintenance manual for Engine, diesel: (Mack Model ENDT 673)

TM 9-2815-213 . . .DS/GS maintenance manual for Engine, diesel: (Cummins Model V8-300)

c. Repair parts mortality has been based on 8 hours of operation per day.

d. *Action Change Codes.* Action change codes listed in the left hand margin of the listing pages denotes the following

| Code            | Definition  |
|-----------------|---|
| C(Change)       | Indicates a change in data other than the FSN since the previous publication. |
| D (Deletion)    | Indicates that an FSN has been deleted and not replaced.                      |
| N (New)         | Indicates an FSN not previously included in the basic publication or changes. |
| R (Replacement) | Indicates that an FSN has been deleted and replaced or changed                |

#### 5. How to Locate Repair Parts

a. *When national stock number or reference number is unknown:*

(1) *First.* Using the table of contents, determine the functional group, i.e., engine, engine assembly, transmission, transmission assembly, 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 functional group to which the repair part belongs and locate the illustration figure and item number notes on the illustration.

b. *When national stock number or reference number is known:*

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

(2) *Second.* Using the Repair Part Listing, find the functional group of the repair part and the illustration figure number and item number

referenced in the Index of National Stock Numbers and Reference Numbers.

## **6. Reporting of Equipment Manual Improvements**

You can improve this manual by recommending

improvements using DA Form 2028 (Recommended Changes to Publications and Blank Forms) and mail the form direct to Commander, US Army Tank-Automotive Command, ATTN: AMSTA-MSP, Warren, MI 48090. A reply will be furnished direct to you.



in column 3 of this publication are —

| <i>Code</i>                            | <i>Used on</i>   |
|--|--|
| A                                      | Starter, Engine Electrical, Delco-Remy Model 1113943                               |
| B                                      | Starter, Engine Electrical, Delco-Remy Model 1113904                               |
| C                                      | Starter, Engine Electrical, Delco-Remy Model 1113944                               |
| <i>b. Applicable publications are:</i> |  |
| TM 9-2320-206                          | Truck, Cargo, 10 ton 6 x 6 (M125)  |
| TM 9-2320-211                          | Truck, Cargo, 5 ton 6 x 6 (M41, M54, M55)  |
| TM 9-2320-230                          | Truck, Cargo, 5 ton 8 x 8 (M656)   |
| TM 9-2815-210                          | DS/GS and depot maintenance manual: Engine (multifuel), (LDS 465-1 and LDS 465-1A) |
| TM 9-2815-207                          | DS/GS maintenance manual for Engine, diesel: (Mack Model ENDT 673)                 |
| TM 9-2815-213                          | DS/GS maintenance manual for Engine, diesel: (Cummins Model V8-300)                |

*c.* Repair parts mortality has been based on 8 hours of operation per day.

### 5. How to Locate Repair Parts

*a.* When Federal stock number or reference number is unknown:

(1) *First.* Using the table of contents, determine the functional group, i.e., engine, engine assembly, transmission, transmission assembly, 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 functional group to which the repair part belongs and locate the illustration figure and item number notes on the illustration.

*b.* When Federal stock number or reference number is known:

(1) *First.* Using the Index of Federal Stock

Numbers and Reference Numbers find the pertinent Federal stock number or reference number. This index is in ascending FSN sequence followed by a list of reference numbers in ascending alphanumeric sequence, cross-reference to the illustration figure number and item number.

(2) *Second.* Using the Repair Part Listing, find the functional group of the repair part and the illustration figure number and item number referenced in the Index of Federal Stock Numbers and Reference Numbers.

### 6. Federal Supply Codes for Manufacturers

| <i>Code</i> | <i>Manufacturer</i>   |
|-------------|---|
| 16764       | Delco-Remy Division of General Motors Corporation<br>2401 Columbus Avenue<br>Anderson, IN 46011       |
| 19207       | Army Tank-Automotive Command<br>Warren, MI 48090  |
| 21450       | Ordnance Corps Engineering Standards,<br>Rock Island Arsenal<br>Rock Island, IL                       |
| 24617       | General Motors Corporation<br>3044 Grand Blvd. W.<br>Detroit, MI 48202                                |
| 72850       | Bendix Corporation<br>18 St. and Oakwood Ave.<br>Elmira, NY 14903                                     |
| 88044       | Aeronautical Standards Group<br>Department of Navy and Air Force                                      |
| 96906       | Military Standards Promulgated by<br>Standardization Division Directorate<br>of Logistic Services DSA |

### 7. Reporting of Equipment Manual Improvements

The reporting of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications) and forwarded directly to Commanding General, U.S. Army Tank-Automotive Command, ATTN: AMSTA-MAP, Warren, MI 48090.



## Section II. DIRECT SUPPORT, GENERAL SUPPORT, AND DEPOT MAINTENANCE REPAIR PARTS LIST

| (1)<br>SMR<br>code | (2)<br>Federal<br>stock<br>No. | (3)<br>Description<br><br>Reference number and mfr code                      Usable on code                                   |   | (4)<br>Unit<br>of<br>measure | (5)<br>Qty.<br>inc<br>in<br>unit | (6)<br>Direct support<br>30-day maint<br>allowance |              |               | (7)<br>General support<br>30-day maint<br>allowance |              |               | (8)<br>1 Yr<br>alw per<br>100<br>equip/<br>cntgcy<br>planning | (9)<br>Depot<br>main<br>alw<br>per<br>100<br>equip | (10)<br>Illustrat    |                |  |
|--------------------|--------------------------------|---|---|------------------------------|----------------------------------|--|--------------|---------------|---|--------------|---------------|---|--|----------------------|----------------|--|
|                    |                                |   |   |                              |                                  | (A)<br>1-20  | (B)<br>21-50 | (C)<br>51-100 | (A)<br>1-20   | (B)<br>21-50 | (C)<br>51-100 |   |  | (a)<br>Figure<br>No. | (b)<br>It<br>m |  |
|                    |                                | <b>GROUP 06 - ELECTRICAL SYSTEM</b>   |   |                              |                                  |  |              |               |   |              |               |   |  |                      |                |  |
|                    |                                | <b>0603 - STARTER MOTOR</b>   |   |                              |                                  |  |              |               |   |              |               |   |  |                      |                |  |
| P-O-R              | 2920-0226-6545                 | STARTER, ENGINE, ELECTRICAL:  | A | EA                           | 1                                |  |              |               |   |              |               |   |  |                      | 63             |  |
|                    |                                | assembly (Components same as Starter, Engine, Electrical, FSN 2920-912-9510 except where individual components are annotated) |   |                              |                                  |  |              |               |   |              |               |   |  |                      |                |  |
|                    |                                | 10911018-1 (19207)  |   |                              |                                  |  |              |               |   |              |               |   |  |                      |                |  |
| P-O-R              | 2920-911-5637                  | STARTER, ENGINE, ELECTRICAL:  | B | EA                           | 1                                |  |              |               |   |              |               |   |  |                      | 63             |  |
|                    |                                | assembly (Components same as Starter, Engine, Electrical, FSN 2920-912-9510 except where individual components are annotated) |   |                              |                                  |  |              |               |   |              |               |   |  |                      |                |  |
|                    |                                | 10911018 (19207)  |   |                              |                                  |  |              |               |   |              |               |   |  |                      |                |  |
| P-O-R              | 2920-912-9510                  | STARTER, ENGINE ELECTRICAL:   | C | EA                           | 1                                |  |              |               |   |              |               |   |  |                      | 63             |  |
|                    |                                | assembly  |   |                              |                                  |  |              |               |   |              |               |   |  |                      |                |  |
|                    |                                | 1113944 (16764)   |   |                              |                                  |  |              |               |   |              |               |   |  |                      |                |  |
| P-F                | 2920-877-2227                  | HOUSING, ENGINE, DRIVE, ELECTRICAL  |   | EA                           | 1                                | *  | *            | *             | *   | *            | *             |   |  |                      | 63             |  |
|                    |                                | STARTER:  |   |                              |                                  |  |              |               |   |              |               |   |  |                      |                |  |
|                    |                                | 1949606 (16764)   |   |                              |                                  |  |              |               |   |              |               |   |  |                      |                |  |
| XBFZZ              |                                | LEVER HOUSING ASSEMBLY:   |   | EA                           | 1                                | *  | *            | *             | *   | *            | *             |   |  |                      | 63             |  |
|                    |                                | 1951069 (16764)   |   |                              |                                  |  |              |               |   |              |               |   |  |                      |                |  |
| P-F                | 6110-757-7187                  | LEVER, STARTER DRIVE:   |   | EA                           | 1                                | *  | *            | *             | *   | *            | *             |   |  |                      | 63             |  |
|                    |                                | 1945484 (16764)   |   |                              |                                  |  |              |               |   |              |               |   |  |                      |                |  |
| P-F                | 2920-807-2408                  | RELAY, SOLENOID:  |   | EA                           | 1                                | *  | *            | *             | *   | *            | *             | *   | *  | *                    | 63             |  |
|                    |                                | 8737877 (19207)   |   |                              |                                  |  |              |               |   |              |               |   |  |                      |                |  |
| P-F                | 2920-086-7979                  | END BELL, ELECTRICAL: assembly  |   | EA                           | 1                                | *  | *            | *             | *   | *            | *             |   |  |                      | 63             |  |
|                    |                                | 1951073 (16764)   |   |                              |                                  |  |              |               |   |              |               |   |  |                      |                |  |
| P-F                | 2920-865-8270                  | WICK:   |   | EA                           | 1                                | *  | *            | *             | *   | *            | *             | *   | *  | *                    | 63             |  |
|                    |                                | 1916439 (16764)   |   |                              |                                  |  |              |               |   |              |               |   |  |                      |                |  |
| P-F                | 5305-068-0515                  | SCREW, CAP, HEXAGON HEAD: end bell and lever housing  |   | EA                           | 9                                | *  | *            | *             | *   | *            | *             | *   | *  | *                    | 63             |  |
|                    |                                | MS90727-8 (96906)   |   |                              |                                  |  |              |               |   |              |               |   |  |                      |                |  |
| P-F                | 5310-582-5965                  | WASHER, LOCK: end bell and lever housing  |   | EA                           | 9                                | *  | *            | *             | *   | *            | *             | *   | *  | *                    | 63             |  |
|                    |                                | MS35338-44 (96906)  |   |                              |                                  |  |              |               |   |              |               |   |  |                      |                |  |
| P-F                | 5977-786-9564                  | HOLDER ASSEMBLY, ELECTRICAL CONTACT   |   | EA                           | 1                                | *  | *            | *             | *   | *            | *             |   |  |                      | 63             |  |
|                    |                                | BRUSH:  |   |                              |                                  |  |              |               |   |              |               |   |  |                      |                |  |
|                    |                                | 1948515 (16764)   |   |                              |                                  |  |              |               |   |              |               |   |  |                      |                |  |

| (1)<br>SMR<br>code | (2)<br>Federal<br>stock<br>No. | (3)<br>Description<br><br>Reference number and mfr code Usable on code  | (4)<br>Unit<br>of<br>measure | (5)<br>Qty.<br>inc<br>in<br>unit | (6)<br>Direct support<br>30-day maint<br>allowance |               |  | (7)<br>General support<br>30-day maint<br>allowance |              |               | (8)<br>1 Yr<br>alw per<br>100<br>equip/<br>cntgcy/<br>planning | (9)<br>Depot<br>main<br>alw<br>per<br>100<br>equip | (10)<br>Illustration |                    |
|--------------------|--------------------------------|---|------------------------------|----------------------------------|--|---------------|--|---|--------------|---------------|--|--|----------------------|--------------------|
|                    |                                |   |                              |                                  | (A)<br>1-20  | (B)<br>21-30  | (C)<br>31-100  | (A)<br>1-20   | (B)<br>21-50 | (C)<br>51-100 |  |  | (a)<br>Figure<br>No. | (b)<br>Item<br>No. |
|                    |                                |   |                              |                                  | P-F  | 5977-754-8153 | 0603-STARTER MOTOR-Continued<br>PARTS KIT, BRUSH, ELECTRICAL: (8 brushes)<br>5702705 (19207) | EA  | 1            | *             |  |  | *                    | *                  |
| P-F                | 5305-984-6191                  | SCREW: brush attaching<br>MS35206-243 (96906)                           | EA                           | 3                                | *  | *             | *  | *   | *            | *             | *  | *  | 63                   | 31                 |
| P-F                | 5310-045-3299                  | WASHER, FLAT: brush holder<br>MS35338-42 (96906)                        | EA                           | 3                                | *  | *             | *  | *   | *            | *             | *  | *  | 63                   | 33                 |
| P-F                | 5305-984-6193                  | SCREW, MACHINE: brush holder<br>MS35206-245 (96906)                     | EA                           | 3                                | *  | *             | *  | *   | *            | *             | *  | *  | 63                   | 34                 |
| P-F                | 5310-178-9612                  | WASHER, FLAT: armature<br>7348958 (19207)                               | EA                           | 1                                | *  | *             | *  | *   | *            | *             | *  | *  | 63                   | 35                 |
| P-F                | 2920-015-3058                  | ARMATURE, MOTOR:<br>8737876 (19207)                                     | EA                           | 1                                | *  | *             | *  | *   | *            | *             | *  | *  | 63                   | 36                 |
| P-F                | 9320-757-7131                  | RUBBER, SPECIAL SHAPED: drive housing<br>1949619 (16764)                | EA                           | 1                                | *  | *             | *  | *   | *            | *             | *  | *  | 63                   | 37                 |
| P-F                | 2920-973-1559                  | DRIVE, ENGINE, ELECTRICAL STARTER:<br>8712241 (19207)                   | EA                           | 1                                | *  | *             | *  | *   | *            | *             | *  | *  | 63                   | 40                 |
| P-F                | 2920-089-3367                  | PARTS KIT, STARTER SOLENOID:<br>5702706 (19207)                         | EA                           | V                                | *  | *             | *  | *   | *            | *             | *  | *  |                      |                    |
| P-F                | 5365-715-1152                  | Consisting of:<br>RING, RETAINING MS16624-1037 (96906)                  | EA                           | 2                                | *  | *             | *  | *   | *            | *             | *  | *  | 63                   | 8                  |
| KFFZZ              |                                | SPRING, HELICAL COMPRESSION 7748643 (19207)                             | EA                           | 1                                | *  | *             | *  | *   | *            | *             | *  | *  | 63                   | 9                  |
| P-F                | 2920-839-1864                  | BELLOWS, RUBBER 7748637 (19207)   | EA                           | 1                                | *  | *             | *  | *   | *            | *             | *  | *  | 63                   | 10                 |
| X1                 |                                | SCREW, ASSEMBLED WASHER 7748641 (19207)                                 |                              | 4                                | *  | *             | *  | *   | *            | *             | *  | *  | 63                   | 15                 |
| P-F                | 2920-089-3368                  | PARTS KIT, ELECTRICAL ENGINE STARTER:<br>bearing set<br>5702707 (19207) | EA                           | V                                | *  | *             | *  | *   | *            | *             | *  | *  |                      |                    |
| KFFZZ              |                                | Consisting of:<br>BEARING, SLEEVE 10951342 (19207)                      |                              | 1                                | *  | *             | *  | *   | *            | *             | *  | *  | 63                   | 2                  |
| P-F                | 3120-661-8951                  | BEARING, SLEEVE 7748634 (19207)   | EA                           | 1                                | *  | *             | *  | *   | *            | *             | *  | *  | 63                   | 7                  |
| P-F                | 3120-350-4492                  | BEARING, SLEEVE 8380683 (19207)   | EA                           | 1                                | *  | *             | *  | *   | *            | *             | *  | *  | 63                   | 21                 |
| KFFZZ              |                                | PLUG, EXPANSION MS35648-6 (96906)                                       | EA                           | 1                                | *  | *             | *  | *   | *            | *             | *  | *  | 63                   | 22                 |
| P-F                | 2920-089-3369                  | PARTS KIT, GASKET AND PREFORMED PACKING:<br>5702708 (19207)             | EA                           | V                                | *  | *             | *  | *   | *            | *             | *  | *  |                      |                    |
| P-F                | 5330-584-0265                  | Consisting of:<br>PACKING, PREFORMED MS28775-012 (96906)                | EA                           | 1                                | *  | *             | *  | *   | *            | *             | *  | *  | 63                   | 42                 |
| P-F                | 5330-842-1901                  | GASKET 7748635 (19207)  | EA                           | 2                                | *  | *             | *  | *   | *            | *             | *  | *  | 63                   | 3                  |
| P-F                | 5330-291-2786                  | SEAL, PLAIN ENCASED 500013 (21450)                                      | EA                           | 1                                | *  | *             | *  | *   | *            | *             | *  | *  | 63                   | 11                 |
| P-F                | 5330-579-7544                  | PACKING, PREFORMED MS28775-243 (96906)                                  | EA                           | 2                                | *  | *             | *  | *   | *            | *             | *  | *  | 63                   | 12                 |
| P-F                | 5970-734-8918                  | INSULATOR, BUSHING 7348918 (19207)                                      | EA                           | 1                                | *  | *             | *  | *   | *            | *             | *  | *  | 63                   | 23                 |
| P-F                | 5970-734-8919                  | INSULATOR, STUD 7348919 (19207)   | EA                           | 1                                | *  | *             | *  | *   | *            | *             | *  | *  | 63                   | 24                 |

| (1)<br>SMR<br>code | (2)<br>Federal<br>stock<br>No. | (3)<br>Description<br><br>Reference number and mfr code Usable on code | (4)<br>Unit<br>of<br>measure                  | (5)<br>Qty<br>inc<br>in<br>unit | (6)<br>Direct support<br>30-day maint<br>allowance |              |               | (7)<br>General support<br>30-day maint<br>allowance |              |               | (8)<br>1 Yr<br>alw per<br>100<br>equip/<br>cntgcy<br>plan-<br>ning | (9)<br>Depot<br>main<br>alw<br>per<br>100<br>equip | (10)<br>Illustration |                    |    |  |
|--------------------|--------------------------------|--|---|---------------------------------|--|--------------|---------------|---|--------------|---------------|--|--|----------------------|--------------------|----|--|
|                    |                                |  |   |                                 | (A)<br>1-20  | (B)<br>21-50 | (C)<br>51-100 | (A)<br>1-20   | (B)<br>21-50 | (C)<br>51-100 |  |  | (a)<br>Figure<br>No. | (b)<br>Item<br>No. |    |  |
| C                  | 2920-999-2399                  | 0603-STARTER MOTOR-Continued   |   |                                 |  |              |               |   |              |               |  |  |                      |                    |    |  |
|                    |                                | P-F  | BUSHING, STARTER 1942969 (16764)              | EA                              | 1  | *            | *             | *   | *            | *             | *  |  |                      | 63                 | 27 |  |
|                    |                                | KFFZZ  | WASHER, FLAT 8665825 (19207)                  | EA                              | 2  | *            | *             | *   | *            | *             | *  |  |                      | 63                 | 28 |  |
|                    |                                | X1   | GASKET 10951331 (19207)                       |                                 | 3  |              |               |   |              |               |  |  |                      | 63                 | 41 |  |
|                    |                                | P-F  | PACKING, PREFORMED MS28775-010 (96906)        | EA                              | 1  | *            | *             | *   | *            | *             | *  |  |                      | 63                 | 43 |  |
|                    |                                | P-F  | PARTS KIT, THRUST WASHERS:<br>5702709 (19207) | EA                              | V  | *            | *             | *   | *            | *             | *  | *  | *                    |                    |    |  |
|                    |                                |  | Consisting of:                                |                                 |  |              |               |   |              |               |  |  |                      |                    |    |  |
|                    |                                | P-F  | WASHER, FLAT 1911644 (16764)                  | EA                              | 1  | *            | *             | *   | *            | *             | *  |  |                      | 63                 | 5  |  |
|                    |                                | P-F  | RING, RETAINING MS16624-1037 (96906)          | EA                              | 1  | *            | *             | *   | *            | *             | *  |  |                      | 63                 | 8  |  |
|                    |                                | P-F  | WASHER 1936466 (16764)                        | EA                              | 1  | *            | *             | *   | *            | *             | *  |  |                      | 63                 | 13 |  |
| C                  | 5330-584-0266                  | WASHER, NON-METALLIC 1922457 (16764)                                   | EA  | 2                               | *  | *            | *             | *   | *            | *             |  |  | 63                   | 16                 |    |  |
|                    |                                | X1   | SUPPORT 1965419 (16764)                       |                                 | 1  |              |               |   |              |               |  |  | 63                   | 17                 |    |  |
|                    |                                | KFFZZ  | INSULATOR, PLATE 1965421 (24617)              | EA                              | 1  | *            | *             | *   | *            | *             | *  |  |                      | 63                 | 18 |  |
|                    |                                | P-F  | WASHER, FLAT 7529187 (19207)                  | EA                              | 3  | *            | *             | *   | *            | *             | *  |  |                      | 63                 | 32 |  |
|                    |                                | P-F  | BOLT, INTERNAL, WRENCHING 7748639 (19207)     | EA                              | 1  | *            | *             | *   | *            | *             | *  |  |                      | 63                 | 38 |  |
|                    |                                | P-F  | BOLT, INTERNAL, WRENCHING 7748638 (19207)     | EA                              | 5  | *            | *             | *   | *            | *             | *  |  |                      | 63                 | 39 |  |
|                    |                                | P-F  | PARTS, KIT, STARTER DRIVE:<br>5702745 (19207) | AB                              | EA   | V            | *             | *   | *            | *             | *  | *  | *                    |                    |    |  |
|                    |                                |  | Consisting of:                                |                                 |  |              |               |   |              |               |  |  |                      |                    |    |  |
|                    |                                | X1   | DRIVE 11602684 (19207)                        | AB                              |  | 1            |               |   |              |               |  |  |                      | 63                 | 4  |  |
|                    |                                |  | GASKET 11601617 (19207)**                     |                                 |  |              |               |   |              |               |  |  |                      | NI                 |    |  |
|                    | PACKING MS28775-236 (96906)**  |  |   |                                 |  |              |               |   |              |               |  | NI   |                      |                    |    |  |
|                    | WASHER 10951127 (19207)**      |  |   |                                 |  |              |               |   |              |               |  | NI   |                      |                    |    |  |
|                    | PACKING MS9068-152 (96906)**   |  |   |                                 |  |              |               |   |              |               |  | NI   |                      |                    |    |  |
|                    | GASKET 10917157 (19207)**      |  |   |                                 |  |              |               |   |              |               |  | NI   |                      |                    |    |  |
| P-F                | GASKET 7748635 (19207)*        | AB   | EA  | 1                               | *  | *            | *             | *   | *            | *             |  | 63   | 3                    |                    |    |  |
| X1                 | BUSHING 482204 (72850)*        | AB   |   | 1                               |  |              |               |   |              |               |  |  |                      |                    |    |  |
| X1                 | WASHER 11610014 (19207)*       | AB   |   | 1                               |  |              |               |   |              |               |  |  |                      |                    |    |  |

\*Used on starters 2920-226-6545 and 2920-911-5637.  
 \*\*Not used on this series of starters.

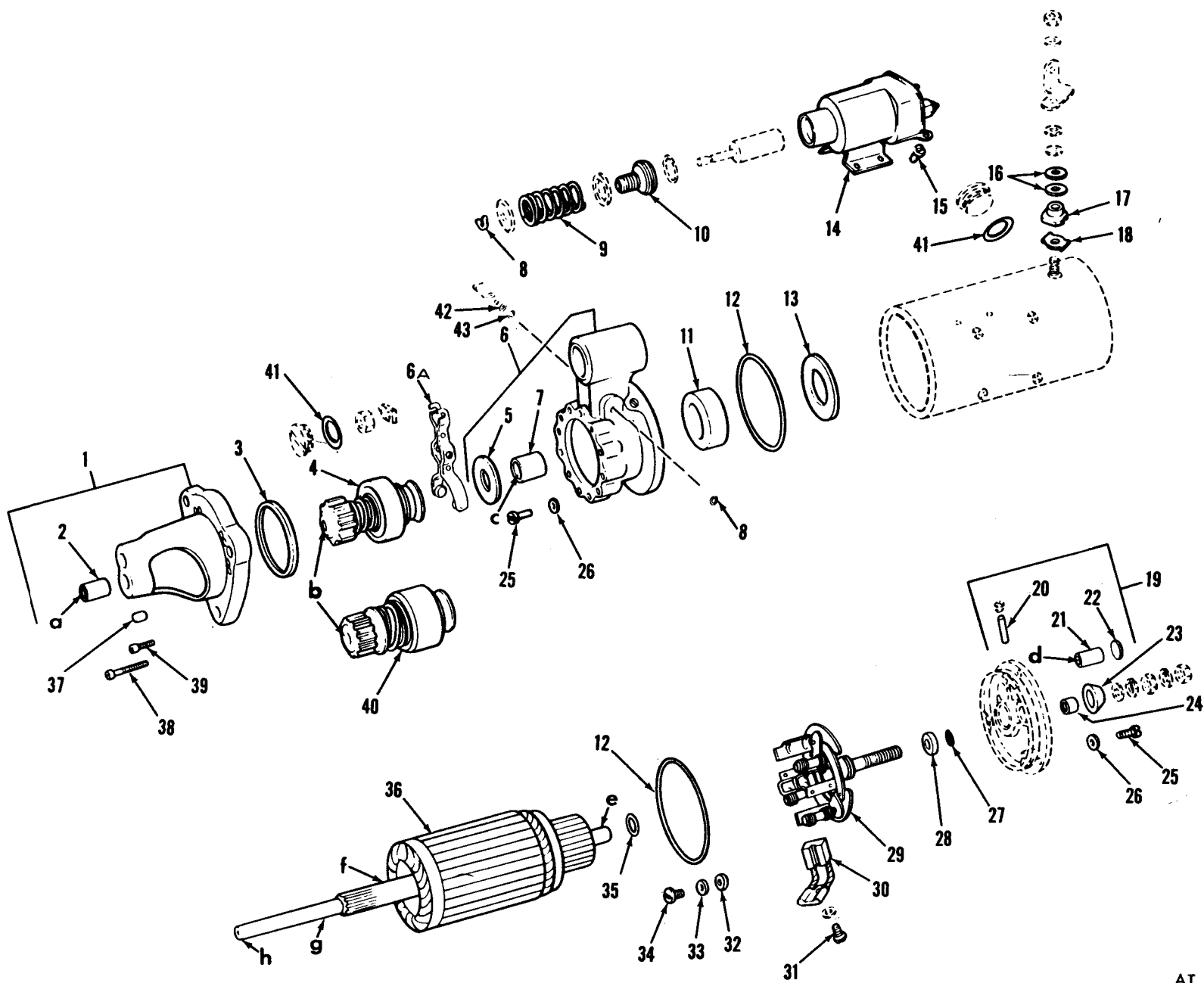


Figure 63. Starter assembly — exploded view.

AT 34312

**Section III.**  
**INDEX – NATIONAL STOCK NUMBER AND REFERENC NUMBER**  
**CROSS-REFERENCE TO FIGURE AND ITEM NUMBER INDEX**

| National Stock Number | Figure No. | Item No.        | National Stock Number | Figure No. | Item No. |
|-----------------------|------------|-----------------|-----------------------|------------|----------|
| 2920-00-015-3058      | 63         | 36              | 5305-00-984-6193      | 63         | 34       |
| 2920-00-060-7252      | Kit        | N.1             | 5306-00-783-5183      | 63         | 39(Kit)  |
| 2920-00-086-7979      | 63         | 19              | 5306-00-783-5188      | 63         | 38(Kit)  |
| 2929-00-089-3367      | Kit        | N.1             |                       |            |          |
| 2920-00-089-3368      | Kit        | N.1             | 5310-00-045-3299      | 63         | 33       |
| 2920-00-089-3369      | Kit        | N.1             | 5310-00-178-9612      | 63         | 35       |
| 2920-00-089-3370      | Kit        | N.1             | 5310-00-262-4753      | 63         | 32(Kit)  |
| 2920-00-226-6545      | 63         | Starter<br>Assy | 5310-00-297-7319      | 63         | 5        |
|                       |            | 14              | 5310-00-582-5965      | 63         | 26       |
| 2920-00-807-2408      | 63         | 10(Kit)         | 5330-00-291-2786      | 63         | 11(Kit)  |
| 2920-00-839-1864      | 63         | 20              | 5330-00-579-7544      | 63         | 12(Kit)  |
| 2920-00-865-8270      | 63         | 1               | 5330-00-584-0265      | 63         | 42(Kit)  |
| 2920-00-877-2227      | 63         | Starter         | 5330-00-584-0266      | 63         | 43(Kit)  |
| 2920-00-911-5637      | 63         | Assy            | 5330-00-719-5470      | 63         | 16(Kit)  |
|                       |            | Starter         | 5330-00-842-1901      | 63         | 3(Kit)   |
| 2920-00-912-9510      | 63         | Assy            | 5340-00-232-5723      | 63         | 22(Kit)  |
|                       |            | 40              | 5360-00-812-0196      | 63         | 9(Kit)   |
| 2920-00-973-1559      | 63         | 27(Kit)         | 5365-00-715-1152      | 63         | 8(Kit)   |
| 2920-00-999-2399      | 63         | 13(KIT)         | 5970-00-734-9818      | 63         | 23(Kit)  |
| 2920-00-999-2527      | 63         | 21(Kit)         | 5970-00-734-8919      | 63         | 24(Kit)  |
| 3120-00-350-4492      | 63         | 7(Kit)          | 5977-00-754-8153      | 63         | 30       |
| 3120-00-661-8951      | 63         | 25              | 5977-00-786-9564      | 63         | 29       |
| 5305-00-068-0515      | 63         | 31              | 6110-00-757-7187      | 63         | 6A       |
| 5305-00-984-6191      | 63         |                 | 9320-00-757-7131      | 63         | 37       |

| Reference No. | Mfg. Code | Fig. No. | Item No. | Reference No. | Mfg. Code | Fig. No. | Item No. |
|---------------|-----------|----------|----------|---------------|-----------|----------|----------|
| MS16624-1037  | 96906     | 63       | 8(Kit)   | 1922457       | 16764     | 63       | 16(Kit)  |
| MS28775-010   | 96906     | 63       | 43(Kit)  | 1936466       | 16764     | 63       | 13(Kit)  |
| MS28775-012   | 96906     | 63       | 42(Kit)  | 1942969       | 16764     | 63       | 27(Kit)  |
| MS28775-243   | 96906     | 63       | 12(Kit)  | 1945484       | 16764     | 63       | 6A       |
| MS35206-243   | 96906     | 63       | 31       | 1948515       | 16764     | 63       | 29       |
| MS35206-245   | 96906     | 63       | 34       | 1949606       | 16764     | 63       | 1        |
| MS35388-42    | 96906     | 63       | 33       | 1949619       | 16764     | 63       | 37       |
| MS35338-44    | 96906     | 63       | 26       | 1951069       | 16764     | 63       | 6        |
| MS35648-6     | 96906     | 63       | 22(Kit)  | 1951073       | 16764     | 63       | 19       |
| MS90727-8     | 96906     | 63       | 25       | 1965419       | 16764     | 63       | 17(Kit)  |
| 10911018      | 19207     | 63       | Starter  | 1965421       | 24617     | 63       | 18(Kit)  |
|               |           |          | Assy     | 482204        | 72850     | N.1      | (Kit)    |
| 10911018-1    | 19207     | 63       | Starter  | 500013        | 21450     | 63       | 11(Kit)  |
|               |           |          | Assy     | 5702705       | 19207     | 63       | 30       |
| 10951331      | 19207     | 63       | 41(Kit)  | 5702706       | 19207     | Kit      | N.1      |
| 10951342      | 19207     | 63       | 2(Kit)   | 5702707       | 19207     | Kit      | N.1      |
| 1113944       | 16764     | 63       | Starter  | 5702708       | 19207     | Kit      | N.1      |
|               |           |          | Assy     | 5702709       | 19207     | Kit      | N.1      |
| 11602684      | 19207     | 63       | 4(Kit)   | 5702745       | 19207     | Kit      | N.1      |
| 11610014      | 19207     | N.1      | (Kit)    | 7348918       | 19207     | 63       | 23(Kit)  |
| 1911644       | 16764     | 63       | 5(Kit)   | 7348919       | 19207     | 63       | 24(Kit)  |
| 1916439       | 16764     | 63       | 20       | 7348958       | 19207     | 63       | 35       |
|               |           |          |          | 7529187       | 19207     | 63       | 32(Kit)  |

| Reference No. | Mfg. Code | Fig. No. | Item No. | Reference No. | Mfg. Code | Fig. No. | Item No. |
|---------------|-----------|----------|----------|---------------|-----------|----------|----------|
| 7749634       | 19207     | 63       | 7(Kit)   | 7748643       | 19207     | 63       | 9(Kit)   |
| 7748635       | 19207     | 63       | 3(Kits)  | 8380683       | 19207     | 63       | 21(Kit)  |
| 7748637       | 19207     | 63       | 10(Kit)  | 8665825       | 19207     | 63       | 28(Kit)  |
| 7748638       | 19207     | 63       | 39(Kit)  | 8712241       | 19207     | 63       | 40       |
| 7748639       | 19207     | 63       | 38(Kit)  | 8737876       | 19207     | 63       | 36       |
| 7748641       | 19207     | 63       | 15(Kit)  | 8737877       | 19207     | 63       | 14       |

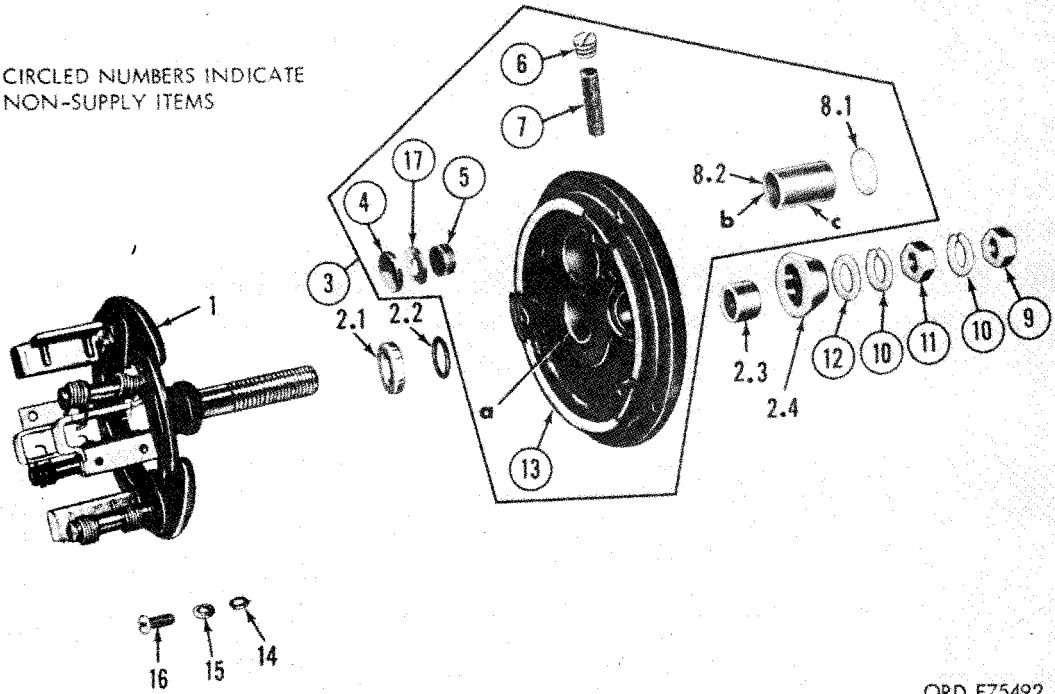


| (1)<br>Illust                                  |                 | (2)<br>Source, maint and recoverability code |               |                           |                        | (3)<br>Federal stock No. | (4)<br>Description  | (5)<br>Unit of issue | (6)<br>Qty inc in unit | (7)<br>15-day maint alw per 100 equip |  | (8)<br>Depot maint guide per 100 equip |
|--|-----------------|--|---------------|---------------------------|------------------------|--------------------------|---|----------------------|------------------------|---------------------------------------|--|--|
| (a)<br>Fig. No.                                | (b)<br>Item No. | (a)<br>Commodity command                     | (b)<br>Source | (c)<br>Main-tenance level | (d)<br>Re-coverability |                          |   |                      | (a)<br>Direct support  | (b)<br>General support                |  |  |
| <b>NONSUPPLY ITEMS—Continued</b>               |                 |  |               |                           |                        |                          |   |                      |                        |                                       |  |  |
|  |                 |  |               |                           |                        |                          | 14—WASHER (16764-9421427).  |                      |                        |                                       |  |  |
|  |                 |  |               |                           |                        |                          | 15—NUT (16764-9414418).   |                      |                        |                                       |  |  |
|  |                 |  |               |                           |                        |                          | 16—NUT (16764-9413509).   |                      |                        |                                       |  |  |
|  |                 |  |               |                           |                        |                          | 17—NUT & LOCKWASHER (16764-1948656).  |                      |                        |                                       |  |  |
|  |                 |  |               |                           |                        |                          | 18—CLIP (16764-1915718).  |                      |                        |                                       |  |  |
|  |                 |  |               |                           |                        |                          | 19—SCREW 916764-1915717).   |                      |                        |                                       |  |  |
|  |                 |  |               |                           |                        |                          | 20—SPRING (16764-1948661).  |                      |                        |                                       |  |  |
| <b>COMMUTATOR END PLATE ASSEMBLY (Fig. 66)</b> |                 |  |               |                           |                        |                          |   |                      |                        |                                       |  |  |
| 66   | 1               |  | P             | F                         | 26                     | 5977-786-9564            | HOLDER ASSEMBLY: electrical contact brush. Refer to fig. 67 (8737875).  | ea                   | 1                      |                                       |  | 10                                     |
|  | 2               |  | P             | F                         | 27                     | 2920-089-3369            | GASKET AND PREFORMED PACKING SET: Starter (5702708).  | ea                   | #                      |                                       |  | 100                                    |
|  | 2.1             |  |               |                           |                        |                          | Composed of:  |                      |                        |                                       |  |  |
|  | 2.2             |  |               |                           |                        |                          | 2—WASHER (8665825).   |                      |                        |                                       |  |  |
|  | 2.3             |  |               |                           |                        |                          | 1—BUSHING (16764-1942969).  |                      |                        |                                       |  |  |
|  | 2.4             |  |               |                           |                        |                          | 1—BUSHING (16764-1918690).  |                      |                        |                                       |  |  |
|  |                 |  | P             | F                         | 28                     | 2920-446-7516            | 1—INSULATOR (7348919).  | ea                   | 1                      |                                       |  | 100                                    |
|  |                 |  | P             | F                         | 29                     | 5330-584-0265            | 1—GASKET (refer to Item 3, fig. 64) (7748635)   | ea                   | 1                      |                                       |  | 100                                    |
|  |                 |  | P             | F                         | 30                     | 5330-050-1218            | 1—PACKING (refer to Item 9, fig. 64) (96906-28775-012)  | ea                   | 1                      |                                       |  | 100                                    |
|  |                 |  | P             | F                         | 31                     | 5330-291-2786            | 1—PACKING (refer to Item 10, fig. 64) (96906-28775-010)   | ea                   | 1                      |                                       |  | 100                                    |
|  |                 |  |               |                           |                        |                          | 1—SEAL (refer to Item 8, fig. 68) (96906-51000-9-2)   | ea                   | 1                      |                                       |  | 100                                    |
|  |                 |  |               |                           |                        |                          | 3—GASKET (refer to Item 8, fig. 63 and Item 4, fig. 64) (10951331).   |                      |                        |                                       |  |  |
|  |                 |  | P             | F                         | 32                     | 5330-579-7544            | 2—PACKING (refer to Item 16, fig. 63 and Item 12, fig. 64) (96906-28775-243).                                       | ea                   | 1                      |                                       |  | 10                                     |
|  | 8               |  | P             | F                         | 33                     | 2920-089-3368            | BEARING SET, SLEEVE: Starter (5702707)  | ea                   | #                      |                                       |  | 100                                    |
|  | 8.1             |  | P             | F                         | 34                     | 5340-282-1668            | Composed of:  |                      |                        |                                       |  |  |
|  | 8.2             |  | P             | F                         | 35                     | 2920-287-8943            | 1—PLUG (96906-35648-6)  | ea                   | 1                      |                                       |  | 10                                     |
|  |                 |  | P             | F                         | 36                     | 3120-661-8951            | 1—BEARING (8380683)   | ea                   | 1                      |                                       |  | 10                                     |
|  |                 |  |               |                           |                        |                          | 1—BEARING (refer to Item 2, fig. 68) (7748634)  | ea                   | 1                      |                                       |  | 50                                     |
|  |                 |  |               |                           |                        |                          | 1—BEARING (refer to Item 3, fig. 69) (10951342).  |                      |                        |                                       |  |  |
|  | 14              |  | P             | F                         | 37                     | 5310-262-4753            | WASHER, FLAT: No. 8 screw size (brush holder to end plate) (**PARTS KIT 2920-089-3370, refer to fig. 64) (7529187). | ea                   | 3                      |                                       |  | 30                                     |



| (1)<br>Illust                     |                    | (2)<br>Source, maint and<br>recoverability code |               |                                  |                                 | (3)               | (4)   | (5)              | (6)                   | (7)<br>15-day maint<br>alw per<br>100 equip |                           | (8)   |
|-----------------------------------|--------------------|---|---------------|----------------------------------|---------------------------------|-------------------|---|------------------|-----------------------|---|---------------------------|---|
| (a)<br>Fig.<br>No.                | (b)<br>Item<br>No. | (a)<br>Com-<br>modity<br>com-<br>mand           | (b)<br>Source | (c)<br>Main-<br>tenance<br>level | (d)<br>Re-<br>cover-<br>ability | Federal stock No. | Description   | Unit<br>of issue | Qty<br>inc in<br>unit | (a)<br>Direct<br>support                    | (b)<br>General<br>support | Depot<br>maint<br>guide<br>per 100<br>equip |
| 66                                | 15                 | -----   | P             | F                                | 037                             | 5310-209-5309     | WASHER, LOCK: No. 8 screw size (brush plate attaching) (96906-35338-23).                | ea               | 3                     | -----                                       | -----                     | 30  |
|                                   | 16                 | -----   | P             | F                                | 037                             | 5305-638-3358     | SCREW, MACHINE: Pan head, No. 8-32NC x 1/2 lg (brush plate attaching) (96906-35223-45). | ea               | 3                     | -----                                       | -----                     | 30  |
| NONSUPPLY ITEMS                   |                    |   |               |                                  |                                 |                   |   |                  |                       |   |                           |   |
| 3—PLATE ASSEMBLY (16764-1951073). |                    |   |               |                                  |                                 |                   |   |                  |                       |   |                           |   |
| 4—PLUG (16764-9417501).           |                    |   |               |                                  |                                 |                   |   |                  |                       |   |                           |   |
| 5—PLUG (16764-1955303).           |                    |   |               |                                  |                                 |                   |   |                  |                       |   |                           |   |
| 6—PLUG (16764-1951874).           |                    |   |               |                                  |                                 |                   |   |                  |                       |   |                           |   |
| 7—WICK (16764-1916439).           |                    |   |               |                                  |                                 |                   |   |                  |                       |   |                           |   |
| 9—NUT (16764-9413509).            |                    |   |               |                                  |                                 |                   |   |                  |                       |   |                           |   |
| 10—WASHER (16764-9421427).        |                    |   |               |                                  |                                 |                   |   |                  |                       |   |                           |   |
| 11—NUT (16764-9414418).           |                    |   |               |                                  |                                 |                   |   |                  |                       |   |                           |   |
| 12—WASHER (8327326).              |                    |   |               |                                  |                                 |                   |   |                  |                       |   |                           |   |
| 13—PLATE (no number).             |                    |   |               |                                  |                                 |                   |   |                  |                       |   |                           |   |
| 17—GASKET (16764-1933111).        |                    |   |               |                                  |                                 |                   |   |                  |                       |   |                           |   |
| BRUSH HOLDER ASSEMBLY (Fig. 67)   |                    |   |               |                                  |                                 |                   |   |                  |                       |   |                           |   |
| NONSUPPLY ITEMS                   |                    |   |               |                                  |                                 |                   |   |                  |                       |   |                           |   |
| 67                                | -----              | -----   | -----         | -----                            | -----                           | -----             | 1—SCREW (16764-1962048).  | -----            | -----                 | -----                                       | -----                     | -----                                       |
|                                   | -----              | -----   | -----         | -----                            | -----                           | -----             | 2—WASHER (16764-453435).  | -----            | -----                 | -----                                       | -----                     | -----                                       |
|                                   | -----              | -----   | -----         | -----                            | -----                           | -----             | 3—SPRING (8393293).   | -----            | -----                 | -----                                       | -----                     | -----                                       |
|                                   | -----              | -----   | -----         | -----                            | -----                           | -----             | 4—HOLDER (16764-1946881).   | -----            | -----                 | -----                                       | -----                     | -----                                       |
|                                   | -----              | -----   | -----         | -----                            | -----                           | -----             | 5—PLATE (16764-1914640).  | -----            | -----                 | -----                                       | -----                     | -----                                       |
|                                   | -----              | -----   | -----         | -----                            | -----                           | -----             | 6—PLATE (16764-1948516).  | -----            | -----                 | -----                                       | -----                     | -----                                       |
|                                   | -----              | -----   | -----         | -----                            | -----                           | -----             | 7—PLATE (16764-1874847).  | -----            | -----                 | -----                                       | -----                     | -----                                       |
|                                   | -----              | -----   | -----         | -----                            | -----                           | -----             | 8—INSULATION (16764-1909523).   | -----            | -----                 | -----                                       | -----                     | -----                                       |
|                                   | -----              | -----   | -----         | -----                            | -----                           | -----             | 9—WASHER (8333310).   | -----            | -----                 | -----                                       | -----                     | -----                                       |
|                                   | -----              | -----   | -----         | -----                            | -----                           | -----             | 10—INSULATION (16764-1965093).  | -----            | -----                 | -----                                       | -----                     | -----                                       |
|                                   | -----              | -----   | -----         | -----                            | -----                           | -----             | 11—PLATE (16764-1914644).   | -----            | -----                 | -----                                       | -----                     | -----                                       |
|                                   | -----              | -----   | -----         | -----                            | -----                           | -----             | 12—SCREW (8333274).   | -----            | -----                 | -----                                       | -----                     | -----                                       |
|                                   | -----              | -----   | -----         | -----                            | -----                           | -----             | 13—SCREW (16764-1962047).   | -----            | -----                 | -----                                       | -----                     | -----                                       |
|                                   | -----              | -----   | -----         | -----                            | -----                           | -----             | 14—SCREW (16764-1944656).   | -----            | -----                 | -----                                       | -----                     | -----                                       |

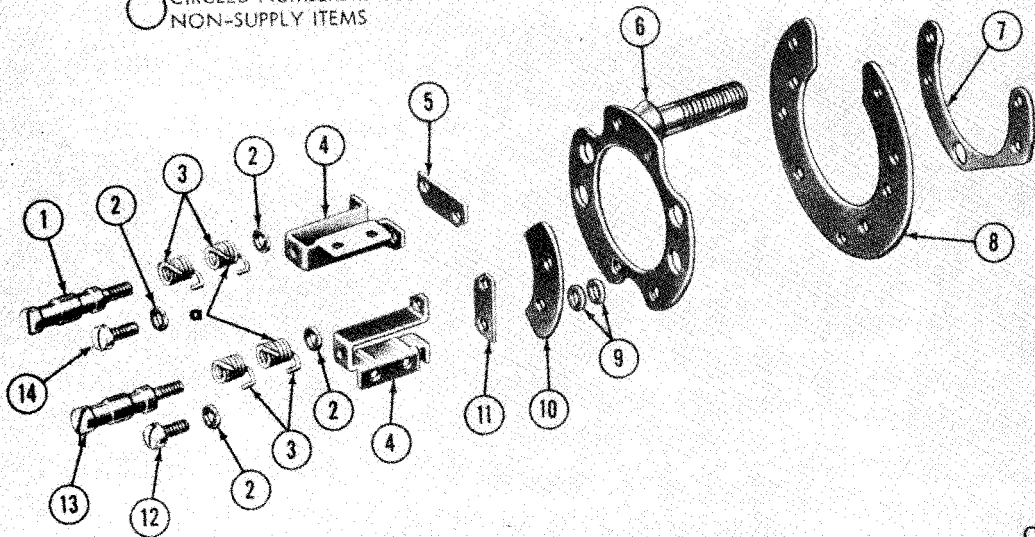
○ CIRCLED NUMBERS INDICATE NON-SUPPLY ITEMS



ORD E75492

Figure 66. Commutator end plate assembly—exploded view.

○ CIRCLED NUMBERS INDICATE NON-SUPPLY ITEMS



ORD E75493

Figure 67. Brush holder assembly—exploded view.

| (1)<br>Illust   |                 | (2)<br>Source, maint and recoverability code |               |                                       |                                 | (3)<br>Federal stock No. | (4)<br>Description  | (5)<br>Unit of issue | (6)<br>Qty inc'n unit    | (7)<br>15-day maint alw per 100 equip |     | (8)<br>Depot maint guide per 100 equip |
|-----------------|-----------------|--|---------------|---------------------------------------|---------------------------------|--------------------------|---|----------------------|--------------------------|---------------------------------------|-----|--|
| (a)<br>Fig. No. | (b)<br>Item No. | (a)<br>Com-<br>modity<br>com-<br>mand        | (b)<br>Source | (c)<br>Main-<br>te-<br>nance<br>level | (d)<br>Re-<br>cover-<br>ability |                          |   |                      | (a)<br>Direct<br>support | (b)<br>General<br>support             |     |  |
| 68              | 2               |  | P             | F                                     | 046                             | 3120-661-8951            | <b>DRIVE LEVER HOUSING ASSEMBLY (Fig. 68)</b><br>BEARING, SLEEVE: lever housing (**BEARING SET 2920-089-3368, fig. 66) (7748634).   | ea                   | 1                        |                                       | 50  |  |
|                 | 8               |  | P             | F                                     | 041                             | 5330-291-2786            | SEAL, PLAIN, ENCASED: lever housing (**GASKET SET 2920-089-3369, fig. 66) (96906-51000-9-2).  | ea                   | 1                        |                                       | 100 |  |
|                 | 9               |  | P             | F                                     | 042                             | 5310-734-8957            | WASHER, BRAKE: lever housing (**PARTS KIT 2920-089 3370, fig. 64) (7348957).  | ea                   | 1                        |                                       | 10  |  |
|                 |                 |  |               |                                       |                                 |                          | <b>NONSUPPLY ITEMS</b>  |                      |                          |                                       |     |  |
|                 |                 |  |               |                                       |                                 |                          | 1—HOUSING ASSEMBLY (16764-1951070).<br>3—HOUSING (no number).<br>4—WICK (16764-1916439).<br>5—PLUG (16764-1951874).<br>6—PLUG (16764-1955303).<br>7—PLUG (16764-9417501).<br>10—GASKET (16764-1933111).                                 |                      |                          |                                       |     |  |
|                 |                 |  |               |                                       |                                 |                          | <b>DRIVE HOUSING ASSEMBLY (Fig. 69)</b>   |                      |                          |                                       |     |  |
|                 |                 |  |               |                                       |                                 |                          | <b>NONSUPPLY ITEMS</b>  |                      |                          |                                       |     |  |
|                 |                 |  |               |                                       |                                 |                          | 1—HOUSING ASSEMBLY (16764-1949607).<br>2—HOUSING (no number).<br>3—BEARING, SLEEVE (10951342).<br>4—PLUG (16764-1951874).<br>5—WICK (16764-1916439).<br>6—PLUG (16764-9417501).<br>7—PLUG (16764-1955303).<br>8—GASKET (16764-1933111). |                      |                          |                                       |     |  |
|                 |                 |  |               |                                       |                                 |                          | <b>DRIVE CLUTCH ASSEMBLY (Fig. 70)</b>  |                      |                          |                                       |     |  |
|                 |                 |  |               |                                       |                                 |                          | <b>NONSUPPLY ITEMS</b>  |                      |                          |                                       |     |  |
|                 |                 |  |               |                                       |                                 |                          | 1—CUP (16764-1945490).  |                      |                          |                                       |     |  |

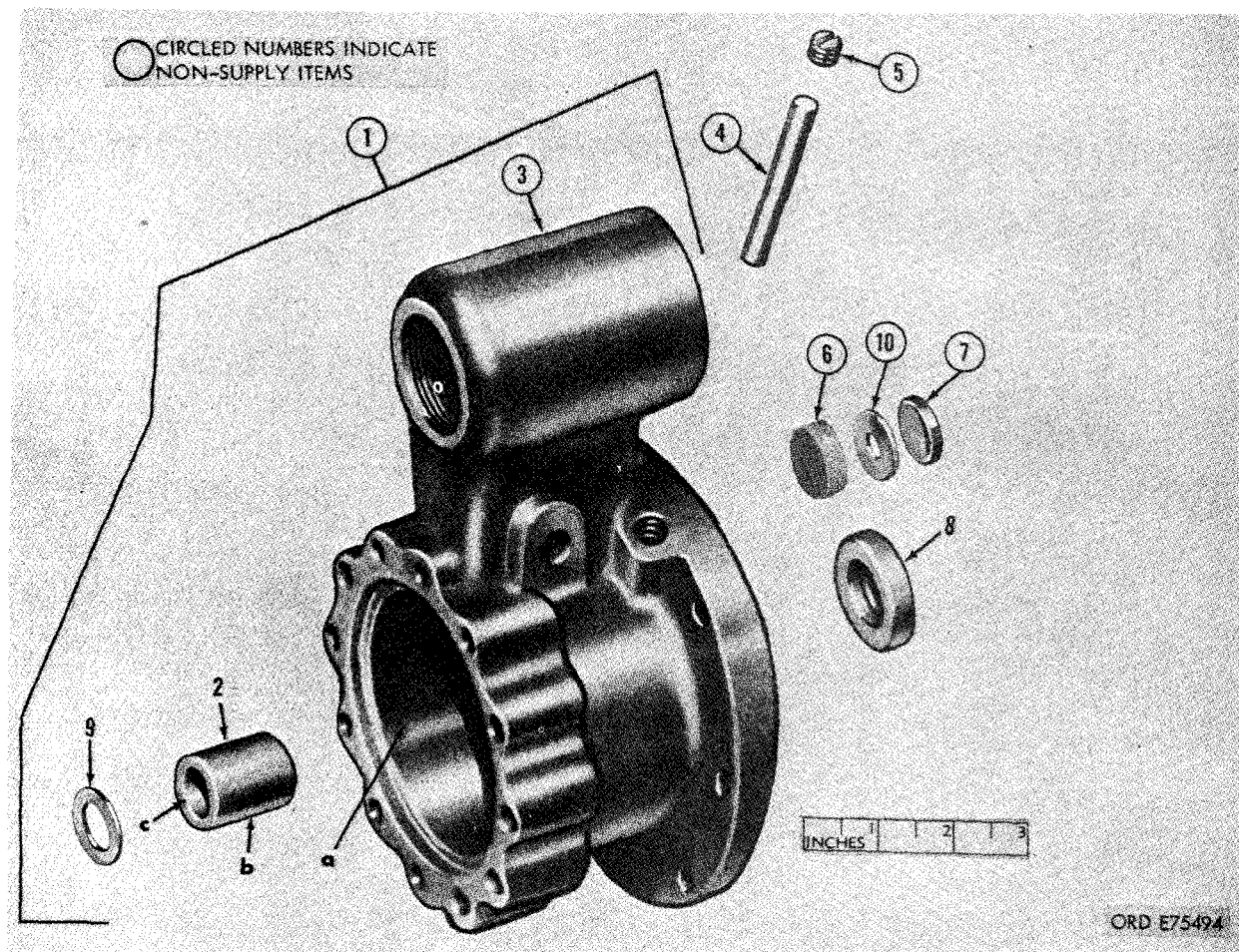


Figure 68. Drive lever housing assembly—exploded view.

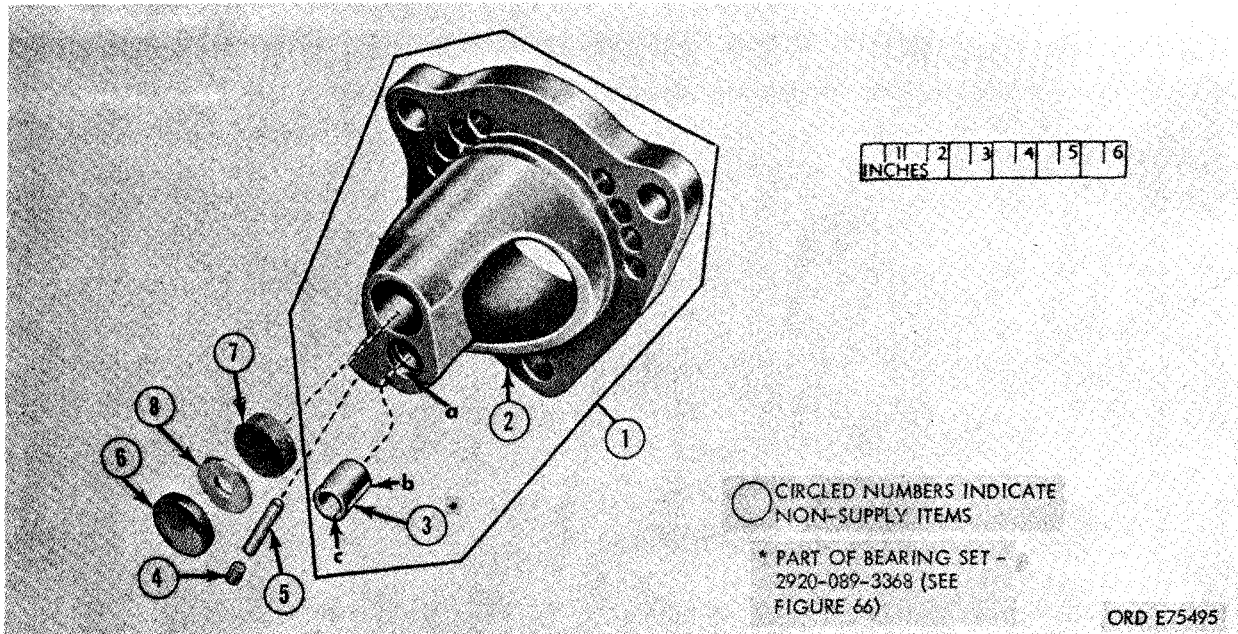


Figure 69. Drive housing assembly—exploded view.

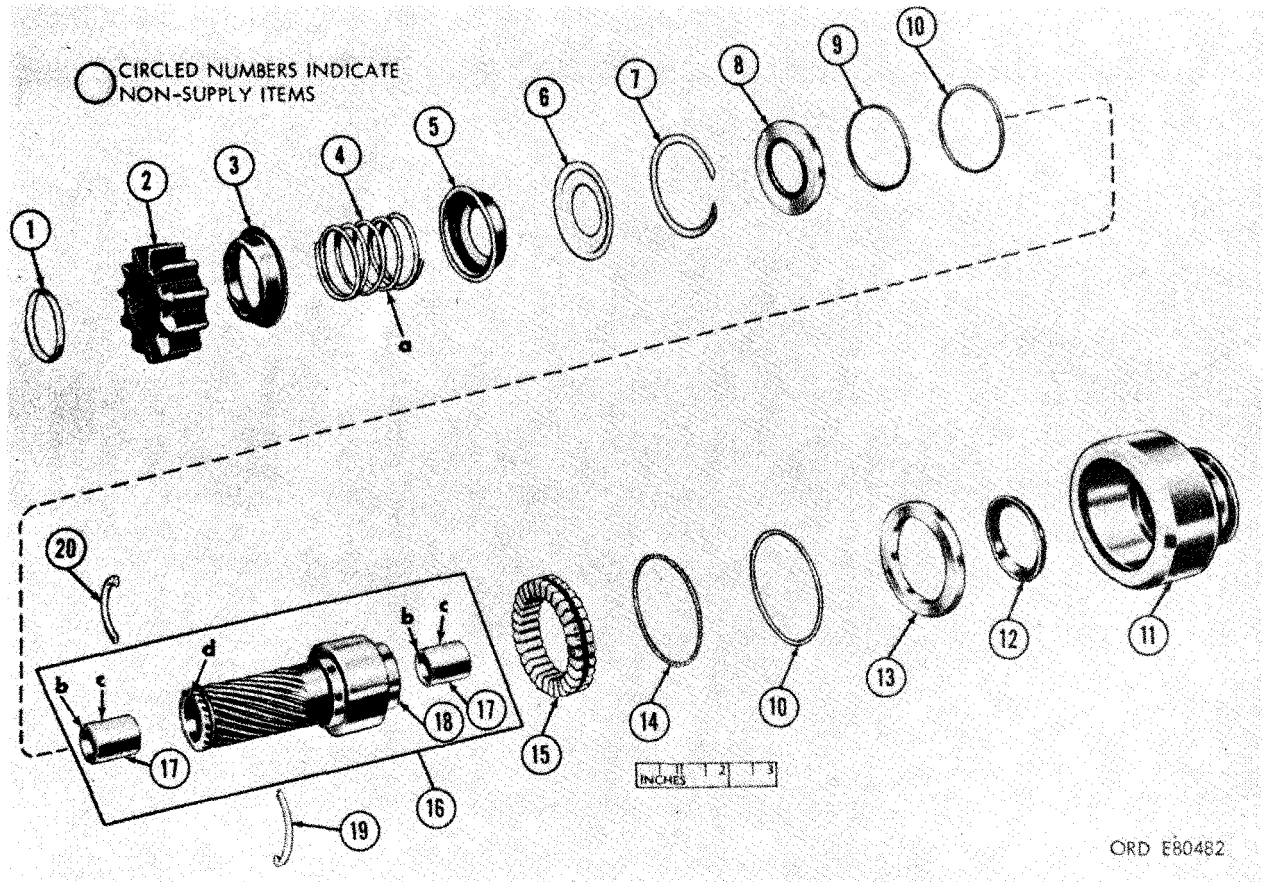


Figure 70. Drive clutch assembly—exploded view.

| (1)<br>Illust      |                    | (2)<br>Source, maint and<br>recoverability code |               |                                       |                                 | (3)<br>Federal stock No. | (4)<br>Description  | (5)<br>Unit<br>of issue | (6)<br>Qty<br>inc in<br>unit | (7)<br>15-day maint<br>slw per<br>100 equip |  | (8)<br>Depot<br>maint<br>guide<br>per 100<br>equip |
|--------------------|--------------------|---|---------------|---------------------------------------|---------------------------------|--------------------------|---|-------------------------|------------------------------|---|--|--|
| (a)<br>Fig.<br>No. | (b)<br>Item<br>No. | (a)<br>Com-<br>modity<br>com-<br>mand           | (b)<br>Source | (c)<br>Main-<br>te-<br>nance<br>level | (d)<br>Re-<br>cover-<br>ability |                          |   |                         | (a)<br>Direct<br>support     | (b)<br>General<br>support                   |  |  |
| 70                 |                    |   |               |                                       |                                 |                          | NONSUPPLY ITEMS—Continued   |                         |                              |   |  |  |
|                    |                    |   |               |                                       |                                 |                          | 2—PINION (16764-1948606).<br>3—CUP (16764-1957177).<br>4—SPRING (16764-1943242).<br>5—CUP (16764-1957264).<br>6—BAFFLE (16764-1957349).<br>7—RING (16764-1959269).<br>8—BEARING W/SEAL (16764-1964849).<br>9—PACKING (16764-1964951).<br>10—WASHER (16764-1956985).<br>11—SHELL (16764-1957437).<br>12—WASHER (16764-1946842).<br>13—BEARING (16764-1964847).<br>14—SPRING (GARTER) (16764-1943238).<br>15—SPRAG (16764-1932033).<br>16—SLEEVE ASSY. (16764-1957184).<br>17—BEARING (16764-812410).<br>18—SLEEVE (no number).<br>19—WASHER, SPLIT (16764-1966451).<br>20—WASHER, SPLIT (16764-1966412). |                         |                              |   |  |  |
| 71                 | 5                  |   | P             | F                                     |                                 | 5330-719-5470            | FRAME ASSEMBLY (Fig. 71)<br>WASHER, NONMETALLIC: coil stud (**PARTS KIT<br>2920-089-3370, fig. 64) (16764-1922457).   | ea                      | 2                            |   |  | 20   |
|                    |                    |   |               |                                       |                                 |                          | NONSUPPLY ITEMS   |                         |                              |   |  |  |
|                    |                    |   |               |                                       |                                 |                          | 1—NUT (16764-9414418).<br>2—WASHER (16764-9421427).<br>3—CONNECTOR (16764-1948507).<br>4—WASHER (8327326).<br>6—SUPPORT (16764-1965419).<br>7—WASHER (16764-1965421).<br>8—INSULATOR (16764-1955990).<br>9—SHOE (16764-1934478).  |                         |                              |   |  |  |

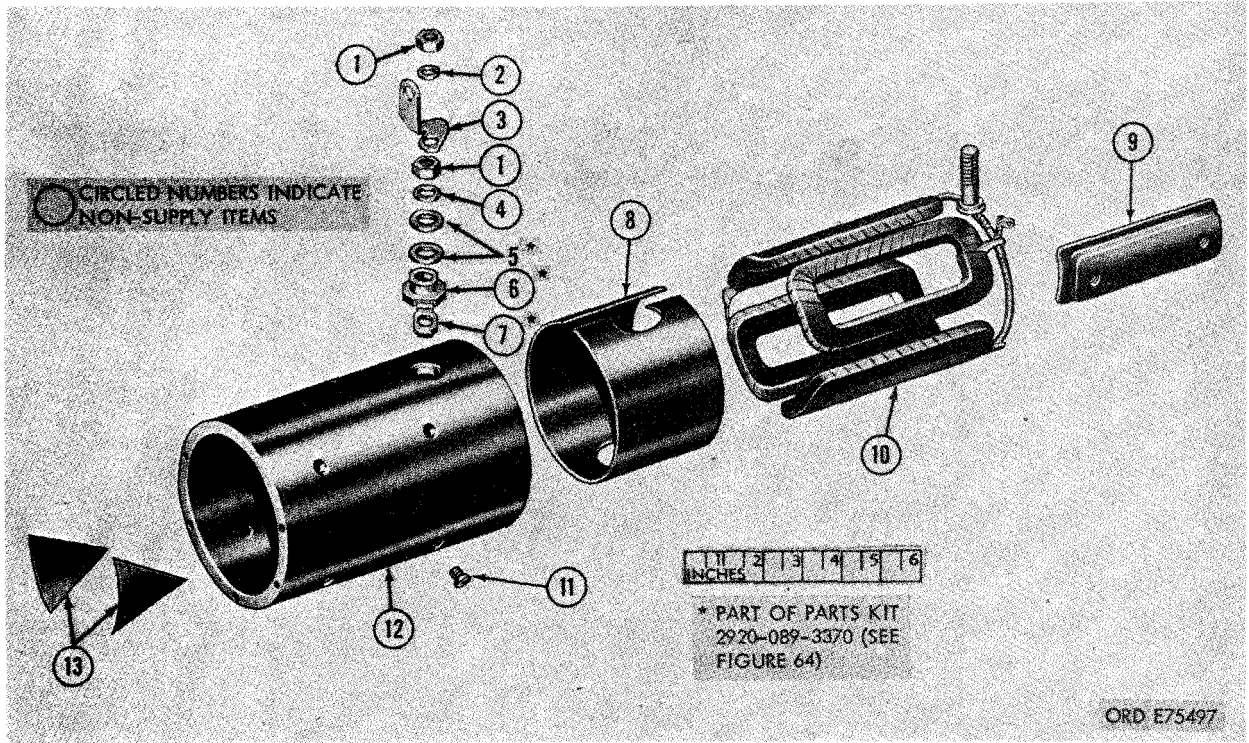


Figure 71. Frame assembly—exploded view.



| (1)<br>Illust      |                    | (2)<br>Source, maint and<br>recoverability code |               |                                       |                                 | (3)               | (4)  | (5)              | (6)                   | (7)<br>15-day maint<br>alw per<br>100 equip |                           | (8)   |
|--------------------|--------------------|---|---------------|---------------------------------------|---------------------------------|-------------------|--|------------------|-----------------------|---|---------------------------|---|
| (a)<br>Fig.<br>No. | (b)<br>Item<br>No. | (a)<br>Com-<br>modity<br>com-<br>mand           | (b)<br>Source | (c)<br>Main-<br>te-<br>nance<br>level | (d)<br>Re-<br>cover-<br>ability | Federal stock No. | Description  | Unit<br>of issue | Qty<br>inc in<br>unit | (a)<br>Direct<br>support                    | (b)<br>General<br>support | Depot<br>maint<br>guide<br>per 100<br>equip |
| 71                 |                    |   |               |                                       |                                 |                   | NONSUPPLY ITEMS—Continued  |                  |                       |   |                           |   |
|                    |                    |   |               |                                       |                                 |                   | 10—COIL (16764-1945496).<br>11—SCREW (16764-1964294).<br>12—FRAME (no number).<br>13—INSULATION (7373225). |                  |                       |   |                           |   |

**STOCK NUMBER INDEX**

| (1)<br>Federal stock No. | (2)<br>Part No. | (3)<br>Illustration |                 | (1)<br>Federal stock No. | (2)<br>Part No.  | (3)<br>Illustration |                 |
|--------------------------|-----------------|---------------------|-----------------|--------------------------|------------------|---------------------|-----------------|
|                          |                 | (a)<br>Fig. No.     | (b)<br>Item No. |                          |                  | (a)<br>Fig. No.     | (b)<br>Item No. |
| 2920-089-3367            | 5702706         | 63                  | 1               | 5306-783-5188            | 7748639          | 64                  | 1.1             |
| 2920-089-3368            | 5702707         | 66                  | 8               | 5306-822-2120            | 7748638          | 64                  | 1.2             |
| 2920-089-3369            | 5702708         | 66                  | 2               | 5310-209-5309            | 96906-35338-23   | 66                  | 15              |
| 2920-089-3370            | 5702709         | 64                  | 1               | 5310-262-4753            | 7529187          | 66                  | 14              |
| 2920-226-6545            | 10911018-1      | 1                   | ---             | 5310-734-8957            | 7348957          | 64                  | 1.3             |
| 2920-287-8943            | 8380683         | 66                  | 8.2             |                          |                  | 68                  | 9               |
| 2920-446-7516            | 7748635         | --                  | ---             | 5330-050-1218            | 96906-28775-010  | 66                  | ---             |
| 2920-758-9958            | 8737874         | --                  | ---             | 5330-291-2786            | 96906-51000-9-2  | 66                  | ---             |
| 2920-777-7166            | 8737876         | 63                  | 19              |                          |                  | 68                  | 8               |
| 2920-807-2408            | 8737877         | 63                  | 6               | 5330-579-7544            | 96906-28775-243  | 63                  | 16              |
| 2920-812-0196            | 7748643         | 63                  | 1.2             |                          |                  | 66                  | ---             |
| 2920-839-1864            | 7748637         | 63                  | 1.3             | 5330-584-0265            | 96906-28775-012  | 66                  | ---             |
| 2920-973-1559            | 8712241         | --                  | ---             | 5330-719-5740            | 16764-1922457    | 71                  | ---             |
| 3120-661-8951            | 7748634         | 66                  | ---             | 5340-282-1668            | 96906-35648-6    | 66                  | 8.1             |
|                          |                 | 68                  | 2               | 5340-715-1152            | 96906-16624-1037 | 64                  | 1.4             |
| 5305-584-7944            | 96906-35304-8   | 63                  | 13              | 5977-786-9564            | 8737875          | 66                  | 1               |
| 5305-638-3358            | 96906-35223-45  | 66                  | 16              | 5877-869-0439            | 5702705          | 63                  | 20              |

**PART NUMBER INDEX**

| (1)<br>Part No. | (2)<br>Federal stock No. | (3)<br>Illustration |                 | (1)<br>Part No. | (2)<br>Federal stock No. | (3)<br>Illustration |                 |
|-----------------|--------------------------|---------------------|-----------------|-----------------|--------------------------|---------------------|-----------------|
|                 |                          | (a)<br>Fig. No.     | (b)<br>Item No. |                 |                          | (a)<br>Fig. No.     | (b)<br>Item No. |
| 5702705         | 5977-869-0439            | 63                  | 20              | 8333274         | -----                    | 67                  | ----            |
| 5702706         | 2920-089-3367            | 63                  | 1               | 8333310         | -----                    | 67                  | ----            |
| 5702707         | 2920-089-3368            | 66                  | 8               | 8380683         | 2920-287-8943            | 66                  | 8.2             |
| 5702708         | 2920-089-3369            | 66                  | 2               | 8393293         | -----                    | 67                  | ----            |
| 5702709         | 2920-089-3370            | 64                  | 1               | 8665*25         | -----                    | 66                  | 2.1             |
| 7348919         | -----                    | 66                  | 2.4             | 8712241         | 2920-973-1559            | --                  | ----            |
| 7348957         | 5310-734-8957            | 64                  | 1.3             | 8737873         | -----                    | 63                  | 20.1            |
|                 |                          | 68                  | 9               | 8737874         | 2920-758-9558            | --                  | ----            |
| 7348958         |                          |                     |                 | 8737875         | 5977-786-9564            | 66                  | 1               |
| 7373225         | -----                    | 71                  | ----            | 8737876         | 2920-777-7166            | 63                  | 19              |
| 7529187         | 5310-262-4753            | 66                  | 14              | 8737877         | 2920-807-2408            | 63                  | 6               |
| 7748634         | 3120-661-8951            | 66                  | ---             | 10951331        | -----                    | 64                  | ----            |
|                 |                          | 68                  | 2               |                 |                          | 66                  | ----            |
| 7748635         | 2920-446-7516            |                     |                 | 10951342        | -----                    | 66                  | ----            |
| 7748637         | 2920-839-1864            | 63                  | 1.3             |                 |                          | 69                  | ----            |
| 7748638         | 5306-822-2120            | 64                  | 1.2             | 10911018-1      | 2920-226-6545            | 1                   | ----            |
| 7748639         | 5306-783-5188            | 64                  | 1.1             | 16764-453435    | -----                    | 67                  | ----            |
| 7748641         | -----                    | 63                  | 1.4             | 16764-812410    | -----                    | 70                  | ----            |
| 7748643         | 2920-812-0196            | 63                  | 1.2             | 96906-35304-8   | 5305-584-7944            | 63                  | 13              |
| 8327326         | -----                    | 65                  | ----            | 96906-35648-6   | 5340-282-1668            | 66                  | 8.1             |
|                 |                          | 66                  | ----            | 16764-1840633   | -----                    | --                  | ----            |
|                 |                          | 71                  | ----            | 16764-1874847   | -----                    | 67                  | ----            |
| 8327432         | -----                    | 64                  | ----            | 16764-1909523   | -----                    | 67                  | ----            |

| (1)<br>Part No. | (2)<br>Federal stock No. | (3)<br>Illustration |                    | (1)<br>Part No.  | (2)<br>Federal stock No. | (3)<br>Illustration |                    |
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| 16764-1914640   | .....                    | 67                  | ...                | 16764-1953236    | .....                    | ...                 | ...                |
| 16764-1914644   | .....                    | 67                  | ...                | 16764-1953242    | .....                    | ...                 | ...                |
| 16764-1915536   | .....                    | ...                 | ...                | 16764-1953244    | .....                    | ...                 | ...                |
| 16764-1915716   | .....                    | ...                 | ...                | 16764-1954861    | .....                    | ...                 | ...                |
| 16764-1915717   | .....                    | 65                  | ...                | 16764-1955303    | .....                    | 66                  | ...                |
| 16764-1915718   | .....                    | 65                  | ...                |                  |                          | 68                  | ...                |
| 16764-1916439   | .....                    | 66                  | ...                |                  |                          | 69                  | ...                |
|                 |                          | 68                  | ...                | 16764-1955990    | .....                    | 71                  | ...                |
|                 |                          | 69                  | ...                | 16764-1956985    | .....                    | 70                  | ...                |
| 16764-1918690   | .....                    | 66                  | 2.3                | 16764-1957177    | .....                    | 70                  | ...                |
| 16764-1922457   | 5330-719-5740            | 71                  | 2.3                | 16764-1957184    | .....                    | 70                  | ...                |
| 16764-1931673   | .....                    | 65                  | ...                | 16764-1957264    | .....                    | 70                  | ...                |
| 16764-1932033   | .....                    | 70                  | ...                | 16764-1957349    | .....                    | 70                  | ...                |
| 16764-1933111   | .....                    | 66                  | ...                | 16764-1957437    | .....                    | 70                  | ...                |
|                 |                          | 68                  | ...                | 16764-1959269    | .....                    | 70                  | ...                |
|                 |                          | 69                  | ...                | 16764-1962047    | .....                    | 67                  | ...                |
| 16764-1934478   | .....                    | 71                  | ...                | 16764-1962048    | .....                    | 67                  | ...                |
| 16764-1936466   | .....                    | ...                 | ...                | 16764-1964294    | .....                    | 71                  | ...                |
| 16764-1942969   | .....                    | 65                  | ...                | 16764-1964839    | .....                    | ...                 | ...                |
|                 |                          | 66                  | 2.2                | 16764-1964847    | .....                    | 70                  | ...                |
| 16764-1943238   | .....                    | 70                  | ...                | 16764-1964849    | .....                    | 70                  | ...                |
| 16764-1943242   | .....                    | 70                  | ...                | 16764-1964951    | .....                    | 70                  | ...                |
| 16764-1944656   | .....                    | 67                  | ...                | 16764-1965093    | .....                    | 67                  | ...                |
| 16764-1944841   | .....                    | 65                  | ...                | 16764-1965419    | .....                    | 71                  | ...                |
| 16764-1946475   | .....                    | 64                  | ...                | 16764-1965421    | .....                    | 71                  | ...                |
| 16764-1945484   | .....                    | 64                  | ...                | 16764-1966412    | .....                    | 70                  | ...                |
| 16764-1945490   | .....                    | 70                  | ...                | 16764-1966451    | .....                    | 70                  | ...                |
| 16764-1945496   | .....                    | 71                  | ...                | 16764-9412305    | .....                    | 64                  | ...                |
| 16764-1946842   | .....                    | 70                  | ...                | 16764-9413509    | .....                    | 65                  | ...                |
| 16764-1946881   | .....                    | 67                  | ...                |                  |                          | 66                  | ...                |
| 16764-1948507   | .....                    | 71                  | ...                | 16764-9414418    | .....                    | 65                  | ...                |
| 16764-1948516   | .....                    | 67                  | ...                |                  |                          | 66                  | ...                |
| 16764-1948519   | .....                    | ...                 | ...                |                  |                          | 71                  | ...                |
| 16764-1948520   | .....                    | ...                 | ...                | 16764-9417501    | .....                    | 68                  | ...                |
| 16764-1948522   | .....                    | ...                 | ...                |                  |                          | 69                  | ...                |
| 16764-1948526   | .....                    | ...                 | ...                | 16764-9421427    | .....                    | 65                  | ...                |
| 16764-1948529   | .....                    | 64                  | ...                |                  |                          | 66                  | ...                |
| 16764-1948606   | .....                    | 70                  | ...                |                  |                          | 71                  | ...                |
| 16764-1948656   | .....                    | 65                  | ...                | 96906-35223-45   | 5305-638-3358            | 66                  | 16                 |
| 16764-1948659   | .....                    | 65                  | ...                | 96906-35338-23   | 5310-209-5309            | 66                  | 15                 |
| 16764-1948661   | .....                    | 65                  | ...                | 96906-35338-25   | .....                    | 63                  | 14                 |
| 16764-1949606   | .....                    | 64                  | ...                | 96906-51000-9-2  | 5330-291-2786            | 66                  | ...                |
| 16764-1949607   | .....                    | 69                  | ...                |                  |                          | 68                  | 3                  |
| 16764-1949619   | .....                    | 64                  | ...                | 96906-28775-010  | 5330-050-1218            | 66                  | ...                |
| 16764-1950111   | .....                    | ...                 | ...                | 96906-28775-012  | 5330-584-0265            | 66                  | ...                |
| 16764-1950145   | .....                    | ...                 | ...                | 96906-28775-243  | 5330-579-7544            | 63                  | 16                 |
| 16764-1951069   | .....                    | ...                 | ...                |                  |                          | 66                  | ...                |
| 16764-1951070   | .....                    | 64                  | ...                | 96906-16624-1037 | 5340-715-1152            | 64                  | 14                 |
| 16764-1951073   | .....                    | 68                  | ...                |                  |                          | 64                  | ...                |
|                 |                          | ...                 | ...                |                  |                          | 66                  | ...                |
| 16764-1951874   | .....                    | 66                  | ...                |                  |                          | 68                  | ...                |
|                 |                          | 68                  | ...                |                  |                          | 69                  | ...                |
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By Order of the Secretary of the Army:

HAROLD K. JOHNSON,  
*General,*  
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*Chief of Staff*

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# The Metric System and Equivalents

## Linear Measure

1 centimeter = 10 millimeters = .39 inch  
 1 decimeter = 10 centimeters = 3.94 inches  
 1 meter = 10 decimeters = 39.37 inches  
 1 dekameter = 10 meters = 32.8 feet  
 1 hectometer = 10 dekameters = 328.08 feet  
 1 kilometer = 10 hectometers = 3,280.8 feet

## Weights

1 centigram = 10 milligrams = .15 grain  
 1 decigram = 10 centigrams = 1.54 grains  
 1 gram = 10 decigrams = .035 ounce  
 1 dekagram = 10 grams = .35 ounce  
 1 hectogram = 10 dekagrams = 3.52 ounces  
 1 kilogram = 10 hectograms = 2.2 pounds  
 1 quintal = 100 kilograms = 220.46 pounds  
 1 metric ton = 10 quintals = 1.1 short tons

## Liquid Measure

1 centiliter = 10 milliliters = .34 fl. ounce  
 1 deciliter = 10 centiliters = 3.38 fl. ounces  
 1 liter = 10 deciliters = 33.81 fl. ounces  
 1 dekaliter = 10 liters = 2.64 gallons  
 1 hectoliter = 10 dekaliters = 26.42 gallons  
 1 kiloliter = 10 hectoliters = 264.18 gallons

## Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch  
 1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches  
 1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet  
 1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet  
 1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres  
 1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

## Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch  
 1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches  
 1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

## Approximate Conversion Factors

| To change     | To                 | Multiply by | To change          | To            | Multiply by |
|---------------|--------------------|-------------|--------------------|---------------|-------------|
| inches        | centimeters        | 2.540       | ounce-inches       | newton-meters | .007062     |
| feet          | meters             | .305        | centimeters        | inches        | .394        |
| yards         | meters             | .914        | meters             | feet          | 3.280       |
| miles         | kilometers         | 1.609       | meters             | yards         | 1.094       |
| square inches | square centimeters | 6.451       | kilometers         | miles         | .621        |
| square feet   | square meters      | .093        | square centimeters | square inches | .155        |
| square yards  | square meters      | .836        | square meters      | square feet   | 10.764      |
| square miles  | square kilometers  | 2.590       | square meters      | square yards  | 1.196       |
| acres         | square hectometers | .405        | square kilometers  | square miles  | .386        |
| cubic feet    | cubic meters       | .028        | square hectometers | acres         | 2.471       |
| cubic yards   | cubic meters       | .765        | cubic meters       | cubic feet    | 35.315      |
| fluid ounces  | milliliters        | 29.573      | cubic meters       | cubic yards   | 1.308       |
| pints         | liters             | .473        | milliliters        | fluid ounces  | .034        |
| quarts        | liters             | .946        | liters             | pints         | 2.113       |
| gallons       | liters             | 3.785       | liters             | quarts        | 1.057       |
| ounces        | grams              | 28.349      | liters             | gallons       | .264        |
| pounds        | kilograms          | .454        | grams              | ounces        | .035        |
| short tons    | metric tons        | .907        | kilograms          | pounds        | 2.205       |
| pound-feet    | newton-meters      | 1.356       | metric tons        | short tons    | 1.102       |
| pound-inches  | newton-meters      | .11296      |                    |               |             |

## Temperature (Exact)

°F Fahrenheit temperature      5/9 (after subtracting 32)      Celsius temperature      °C

