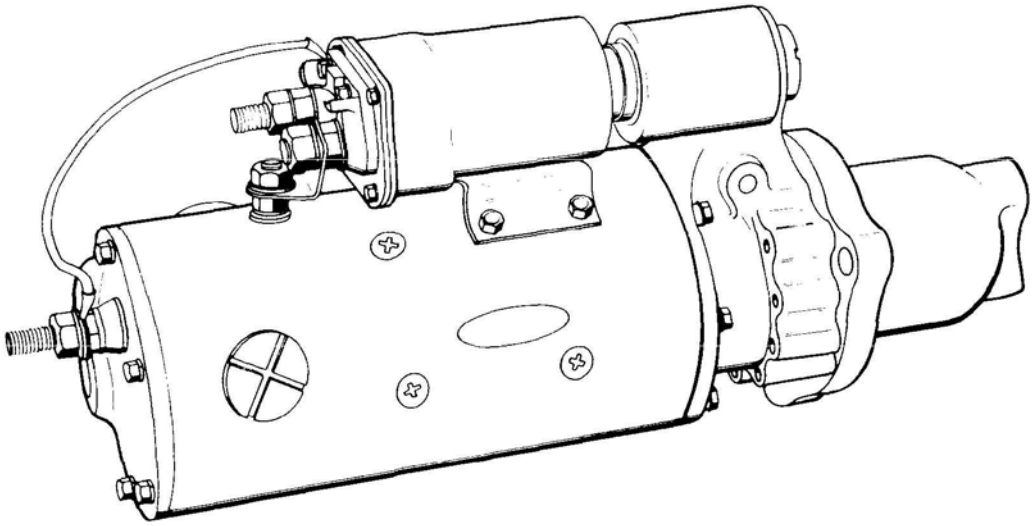
ARMY TM 9-2920-232-34&P
AIR FORCE TO 38X14-2-32

TECHNICAL MANUAL

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL

(Including Direct Support, General Support, and Depot Maintenance Repair Parts and Special Tools Lists)



STARTER, ENGINE, ELECTRICAL, ASSEMBLY DELCO-REMY-GMC

1109972 (2920-00-973-1557)

1990272 (2920-01-139-3722)

Supersedure Notice: This manual supersedes TM 9-2920-232-34&P, dated 28 February 1986, including all changes.

Distribution Statement A: Approved for public release; distribution is unlimited.

HEADQUARTERS, DEPARTMENT OF THE ARMY

DECEMBER 2005

WARNING SUMMARY

WARNING

Dry-cleaning solvent (P-D-680) used to clean parts, is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes. Do not breathe vapors. Do not use near open flame or excessive heat. Do not smoke when using solvent. Failure to do so could cause SERIOUS INJURY. If you become dizzy while using cleaning solvent, get fresh air immediately, and if necessary, get medical attention. If contact with skin or clothes is made, flush thoroughly with water. If the solvent contacts your eyes, flush with water immediately, and obtain medical aid (ref. FM 4-25.11).

WARNING

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

Refer to FM 4-25.11 for first aid instructions.

END ITEM APPLICATION

Engines AVDS-1790-2C, AVDS-1790-2CA, AVDS-1790-2D, AVDS-1790-2DA, and AVDS-1790-2DR.

Vehicles	TM No. Series
Tank, Combat, Full Tracked: 105-MM Gun, M60	9-2350-260
Tank, Combat, Full Tracked: 105-MM Gun, M48A5	9-2350-258
Tank, Combat, Full Tracked: 105-MM Gun, M60 and M60A1	9-2350-215
Tank, Combat, Full Tracked: 105-MM Gun, M60A1 (RISE)	9-2350-257
Tank, Combat, Full Tracked: 105-MM Gun, M60A3	9-2350-253
Armored Vehicle Launched Bridge: M48A2 AVLB	5-5420-200
Armored Vehicle Launched Bridge: M60A1 AVLB	5-5420-202
Armored Vehicle Launched Bridge: M48A5 AVLB	5-5420-226
Vehicle, Combat Engineer, Full Tracked: M728	9-2350-222
Recovery Vehicle, Full Tracked: Medium, M88A1	9-2350-256

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HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington D.C., 31 December 2005

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL

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

STARTER, ENGINE, ELECTRICAL, ASSEMBLY
DELCO-REMY-GMC
1109972 (2920-00-973-1557)
1990272 (2920-01-139-3722)

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this publication. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Submit your DA Form 2028 (Recommended Changes to Equipment Technical Publications), through the Internet on the Army Electronic Product Support (AEPS) website. The Internet address is https://aeps.ria.army.mil. If you need a password, scroll down and click on "ACCESS REQUEST FORM". The DA Form 2028 is located in the ON-LINE FORMS PROCESSING section of the AEPS. Fill out the form and click on SUBMIT. Using this form on the AEPS will enable us to respond quicker to your comments and better manage the DA Form 2028 program. You may also mail, fax or email your letter, DA Form 2028, direct to: Technical Publication Information Office, TACOM-RI, 1 Rock Island Arsenal, Rock Island, IL 61299-7630. The email address is TACOM-TECH-PUBS@ria.army.mil. The fax number is DSN 793-0726 or Commercial (309) 782-0726.

A reply will be furnished directly to you.

TABLE OF CONTENTS

*Supersedes TM 9-2920-232-34&P, dated 28 February 1986.

CHAPTER 4 SUPPORTING INFORMATION

HOW TO USE THIS MANUAL

1. This technical manual describes the Direct Support (DS) and General Support (GS) maintenance and repair requirements for the Delco-Remy GMC, part numbers 1109972 and 1990272, Engine Starter Assemblies (Electrical). To use the maintenance work packages in this manual properly, you must familiarize yourself with the entire work package before beginning the maintenance task. Information in this manual is divided into four chapters and an index. Work packages are numbered sequentially throughout all chapters. Where references are made to tables, figures, and work packages, refer to those portions of the text.
2. Chapter 1 contains the general introductory information and a description of the characteristics, capabilities, and major components of the starters.
3. Chapter 2 lists the common and special tools required to repair the starter. This chapter also contains instructions for inspecting and troubleshooting the starter.
4. Chapter 3 contains the procedures for disassembly, cleaning, inspection, repair, and assembly of the starter. Lubrication instructions and testing, are included in this chapter.
5. Throughout the disassembly portion of this chapter, you are instructed to remove and discard certain items such as gaskets, seals, and bearings. These disposable parts are furnished in various starter parts kits (refer to the Repair Parts and Special Tools List in WP 0015 00).
6. WP 0013 00 is an Illustrated List of Manufactured Items.
7. Chapter 4 contains all supporting information.
8. WP 0014 00, References, provides a listing of U.S. Army publications which apply to this manual.
9. WP 0015 00 is the Repair Parts and Special Tools List.
10. WP 0016 00, Expendable Supplies and Materials is a list of consumable material required to maintain the starter at DS/GS level.
11. WP 0017 00 is a Tool Identification List.
12. An alphabetical index is also provided at the end of this manual, and a metric conversion table is included on the inside back cover.

GENERAL INFORMATION 0001 00

THIS WORK PACKAGE COVERS:
General Information

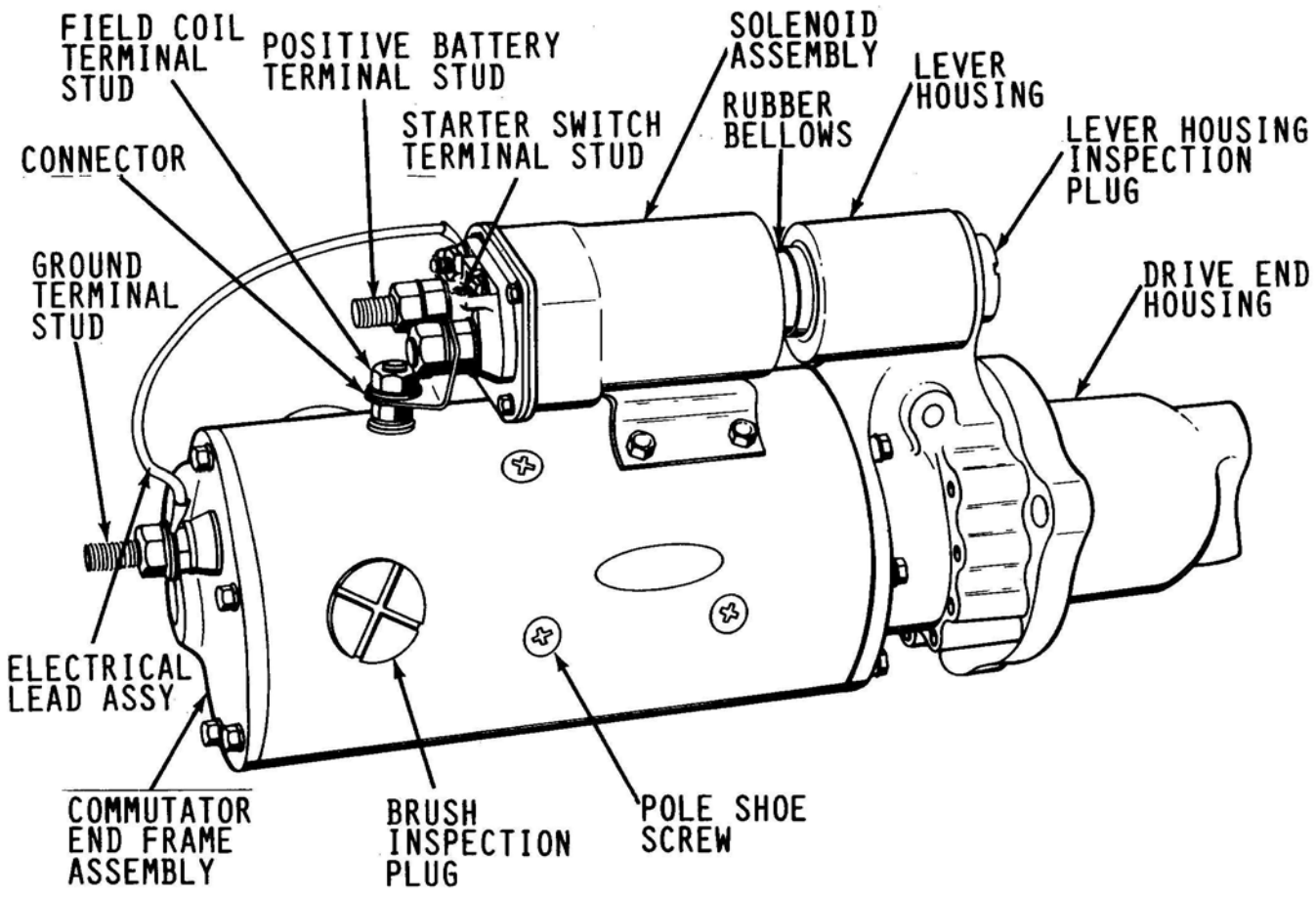


Figure 1-1. Engine Starter Assembly (Electrical)

SCOPE

Type of Manual: This technical manual contains instructions for maintenance and repair of Delco-Remy-GMC, part numbers 1109972 and 1990272, Starter Assemblies (fig. 1-1) at Direct and General Support levels.

Equipment Identification: The two configurations of the starter assemblies covered in this manual are part numbers 1109972 (12-brush) and 1990272 (6-brush). Either configuration can be mounted on AVDS-1790 series engines used in army vehicles. The 12-brush starter can be changed into a 6-brush starter. (Refer to Work Package WP 0006 00.)

Purpose of the Equipment: The starters are high torque electric motors used for cranking internal combustion engines during the engine start cycle.

Superseded Manual: This manual differs from TM 9-2920-232-34/TO 38X14-2-32 (Feb 86), which it supersedes, in format to MIL-STD-40051.

GENERAL INFORMATION - CONTINUED 0001 00

DS/GS ALLOCATIONS

Refer to maintenance allocation chart in TM 9-2350-253-20 for assignment of maintenance functions.

MAINTENANCE FORMS, RECORDS AND REPORTS

Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA PAM 750-8. The Army Maintenance Management System (TAMMS) as contained in the Maintenance Management update.

Accidents involving injury to personnel or damage to materiel will be reported on DA Form 285 (Accident Reporting) in accordance with AR 385-40.

REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS

If your starter assembly needs improvement, let us know. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design or performance. Put it on a SF 368 (Quality Deficiency Report). Mail it to the address specified in DA PAM 750-8.

CORROSION PREVENTION AND CONTROL

Corrosion Prevention and Control (CPC) or Army materiel is a continuing concern It is important that any corrosion problem with the starter be reported so that improvements can be made to prevent the problem in the future. While corrosion is typically associated with rusting of metals, it can also include deterioration of other materials such as rubber and plastic. Unusual cracking, softening, swelling, or breaking of these materials may be a corrosion problem. If a corrosion problem is identified, it can be reported using SF 368, (Product Quality Deficiency Report). Use of keywords such as "corrosion", "rust", deterioration", or "cracking" will ensure that the information is identified as a CPC problem. SF 368 should be submitted to the address specified in DA PAM 750-8.

DESTRUCTION OF ARMY MATERIEL TO PREVENT ENEMY USE

Refer to TM 750-244-6 for procedures on how to destroy the starter.

Below are some general guidelines to follow in destruction of equipment to prevent enemy use.

Destruction of equipment, when subject to capture or abandonment in a combat zone, will be undertaken only when such action is necessary in accordance with orders of, or policy established by the Army commander.

In general, destruction of essential parts, followed by burning, will usually be sufficient to render equipment useless. Time is usually critical.

Material must be damaged so that it cannot be restored to usable condition by either repair or cannibalization. If lack of time or personnel prevents destruction of all parts, give priority to destruction of parts hardest to replace. It is important that the same parts be destroyed on all starters to prevent construction of one complete starter from several damaged ones.

PREPARATION FOR STORAGE AND SHIPMENT

Refer to TM 9-2350-256-20 for instructions on preparation for storage and shipment.

QUALITY OF MATERIAL

Material used for replacement, repair, or modification must meet the requirements of this manual. If quality of material requirements are not stated in this manual, the material must meet the requirements of the drawings, standards, specifications, or approved engineering change proposals applicable to the subject equipment.

END OF WORK PACKAGE

CHAPTER 1

INTRODUCTION

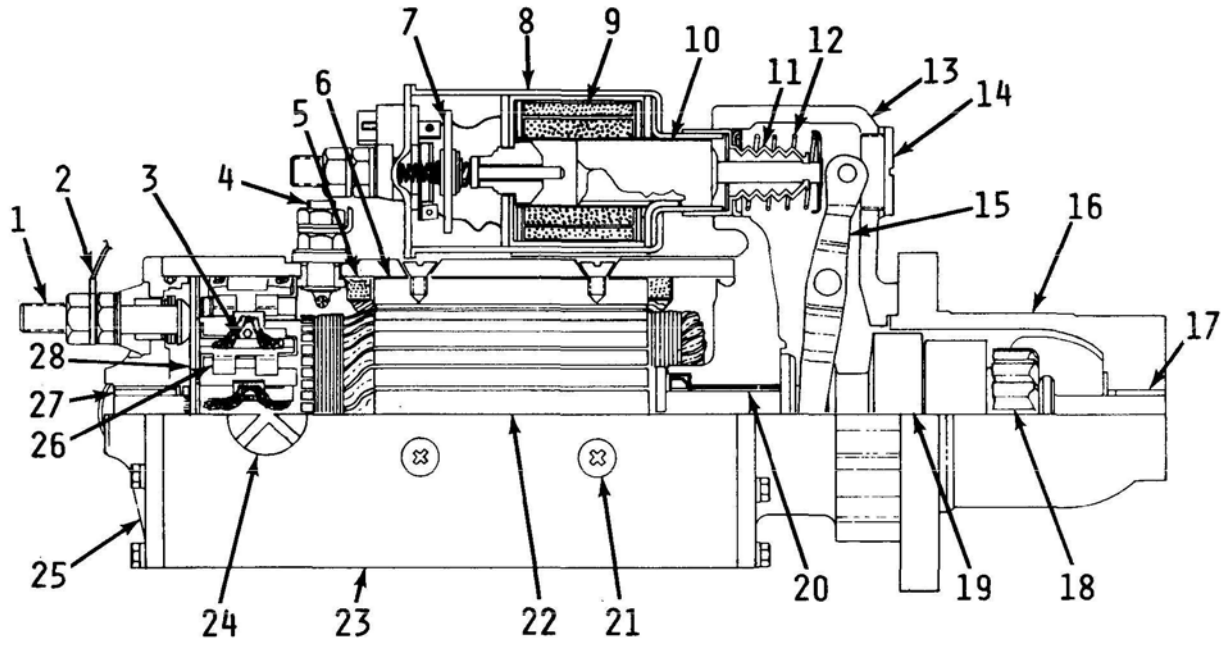
EQUIPMENT DESCRIPTION AND DATA 0002 00

THIS WORK PACKAGE COVERS:

Equipment Description and Data

GENERAL DESCRIPTION OF STARTER

The Electrical Engine Starter is a heavy-duty, 24-volt DC cranking motor for large diesel engines. It is insulated and waterproof, and is resistant to both fungus and corrosion. Its output drive pinion is moved into mesh with an engine starter drive gear by a solenoid operated, enclosed shift lever. The starter motor output torque is applied to the drive pinion through a heavy-duty overrunning clutch which prevents an engine from back-driving motor armature. Pinion end clearance is adjustable.



1. Brush holder terminal stud
2. Electrical lead assembly
3. Brush
4. Field winding terminal stud
5. Field winding
6. Pole shoe
7. Contact assembly
8. Solenoid relay assembly
9. Solenoid windings
10. Solenoid plunger
11. Rubber bellows
12. Plunger spring
13. Lever housing
14. Lever housing inspection plug
15. Shift lever
16. Drive housing
17. Sleeve bearing
18. Drive pinion
19. Drive clutch assembly
20. Sleeve bearing
21. Pole shoe screw
22. Armature
23. Frame assembly
24. Brush inspection plug
25. Commutator end plate assembly
26. Brush spring
27. Sleeve bearing
28. Brush holder assembly

Figure 1-2. Sectional View of Starter

EQUIPMENT DESCRIPTION AND DATA - CONTINUED 0002 00

DETAILED DESCRIPTION OF STARTER

NOTE

Reference numbers shown in parentheses refer to the sectional view of the starter (fig. 1-2).

a. Major Components. The major components of the starter are the frame assembly (23), armature (22), commutator end plate assembly (25), brush holder assembly (28), brushes (3), drive clutch assembly (19), drive housing (16), solenoid relay assembly (8), lever housing (13), shift lever (15), and solenoid plunger (10).

b. Frame Assembly. The frame assembly consists of field windings (5), pole shoes (6), and field winding terminal stud (4) mounted in and supported by the heavy steel cylindrical frame.

1) Field windings (5) are held in position on inside wall of the frame by the pole shoes (6). Each pole shoe is secured in place by two screws (21). Field windings are electrically interconnected in an arrangement of three pairs.

2) Each pair of field windings (5) are series connected, but reverse winding makes opposite polarity. All three pairs have a common connection at the field winding terminal stud (4). The field winding terminal stud is insulated from the frame in which it is mounted.

c. Armature. The armature (22) is made of copper and laminated steel assembled on a steel shaft. When installed, the armature is supported by three sleeve bearings (17, 20, and 27) and is free to rotate in the frame assembly.

1) A straight spline on drive end of armature shaft engages the internal spline of drive clutch-assembly (19) so that it must rotate with the shaft but allows movement of the drive clutch assembly along the shaft.

2) Movement of drive clutch assembly (19) along the shaft provides the means of engaging and disengaging starter drive pinion (18) from the teeth on an engine's starter drive gear.

3) A commutator, at end opposite drive end of the armature, provides selective electrical contact through brushes (3) as the armature rotates. This selective contact allows electrical current to flow through each armature winding in alternating directions as the armature rotates. As the current direction through a winding changes, magnetic polarity of the associated armature pole is reversed. These changes in polarity always force, in a pull and then push fashion, rotation of an armature pole past each pole shoe in one constant direction.

d. Commutator End Plate Assembly. The end plate of commutator end plate assembly (25) provides closure for that end of the starter frame and holds sleeve bearing (27) which supports the commutator end of armature (22). Brush holder assembly (28) has six brush holders and is mounted on the inner surface of the end plate but is electrically insulated from the end plate as necessary.

e. Brushes and Brush Holder Assemblies. Each brush is free to move in its brush holder only in a radial direction with respect to the circumference of the commutator. A helical torsion spring (26) is used (two in 12-brush starter) at each brush holder to keep a positive contact pressure between brush and commutator. These springs and brush freedom in its holder accommodate change in brush length due to wear.

1) Alternate brush holders around commutator are electrically connected to provide one set of three brushes (three pairs of brushes in p/n 1109972) in common circuit. This set is connected to brush holder terminal stud (1).

EQUIPMENT DESCRIPTION AND DATA - CONTINUED 0002 00

2) Brush holder terminal stud (1) extends through but is insulated from the end plate. This stud is used for connection to the ground of the power supply as shown schematically in the diagram of internal motor circuits (fig. 1-3).

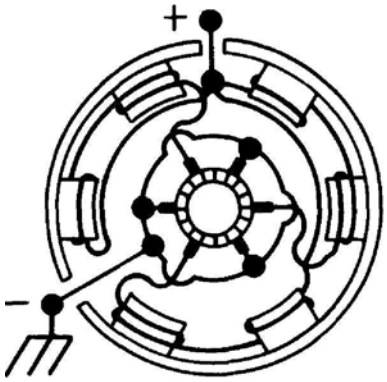


Figure 1-3. Internal Motor Circuits

3) Each of the remaining brushes (or brush pairs) is in circuit with an assigned pair of series-connected field windings. Starter, part number 1990272, has one brush and starter, part number 1109972, has two brushes in each of six brush holders. Refer to paragraph 1-9 for design specifications.

f. Drive Housing. Drive housing (16) gives support to the bearing at drive-end of the armature shaft and houses a portion of the drive clutch assembly (19). The drive housing is also the mounting flange for the starter and has three holes for bolts which attach the starter to an engine. The drive housing has a bolt hole pattern which permits it to be attached to lever housing (13) with the opening for drive pinion (18) access at anyone of 24 different rotational positions. Only one of these positions is correct for a particular engine application. Unused holes in this pattern are sealed with spherical rubber plugs.

g. Lever Housing. Lever housing (13) supports the center bearing for the armature, provides a mounting point for the drive housing, and provides a closure for drive end of the starter frame. It houses the inner portion of the drive clutch assembly. It supports and houses the shift mechanism.

h. Drive Clutch Assembly. Drive clutch assembly (19) is made up of an overrunning clutch, drive pinion (18), and a pinion engaging spring. The armature bore of this assembly has a straight spline which allows movement along the armature shaft, but locks clutch sleeve to armature shaft in rotation. The overrunning clutch is a seven-roll assembly which allows rotation of the pinion sleeve within the clutch sleeve. Independent rotation of input or output can occur in one direction only.

i. Solenoid Assembly. Solenoid relay assembly (8) is a heavy-duty, electro-magnetically actuated switch. It has stud terminals at one end for connection to a power source and to the motor field winding terminal stud (4). Its case houses solenoid windings (9) and switch mechanism. The case mounts directly on frame assembly with four screws. The solenoid has two concentric windings: a pull-in winding and a hold-in winding. There are the same number of turns in each winding, but the pull-in winding is coarser wire than the hold-in winding.

j. Solenoid Plunger. Solenoid plunger (10) is the moveable core for the solenoid windings. It attaches to shift lever (15) and provides for adjustment of pinion clearance.

k. Shift Lever. Shift lever (15) pivots on a cross shaft supported by lever housing (13). This lever is positioned by the solenoid acting on solenoid plunger (10) or by plunger spring (12) when solenoid is not energized. The end of lever opposite that which connects to the plunger is a yoke for pushing drive clutch assembly (19) until drive pinion (18) is into mesh with the engine starter drive gear.

EQUIPMENT DESCRIPTION AND DATA - CONTINUED 0002 00

EQUIPMENT DATA		MOUNTING DATA	
Rated Voltage	24 vdc	Diameter of Mounting Bolt Holes (Nominal)	0.659 in.
Minimum Output Torque at Stall (4.4 Volts and 800 Amperes)	55 lb-ft	Diameter of Mounting Bolt Hole Circle.	5.75 in.
No Load Pinion Speed (Rated Voltage)	6180 to 9180 rpm	Overall Length of Starter (nominal)	20.65 in.
Direction of Rotation (Facing Drive End)	Clockwise	Outside Maximum Diameter	9.9 in.
Number of Teeth (Drive Pinion)	11	Weight of Starter Assembly (approximate)	80 lbs
Number of Holes for Mounting Bolts	3		

END OF WORK PACKAGE

THEORY OF OPERATION 0003 00

THIS WORK PACKAGE COVERS:

Theory of Operation

DETAILED OPERATION

a. When 24 VDC power source is properly connected to ground terminal of starter motor and to BAT terminal of the solenoid assembly, any circuit which will apply this same voltage to terminal S on the solenoid assembly will energize the solenoid windings. Pull-in winding will initially be grounded through the motor windings and commutator (a low resistance path); the hold-in winding is connected direct to ground by the electrical lead assembly.

b. Current flow through the solenoid windings creates a magnetic field which pulls the plunger into the solenoid assembly. This movement linked through the shift lever slides drive clutch assembly nearer to drive end of the armature shaft (engaging pinion gear with an engine drive gear, if starter were mounted on an engine).

c. As the plunger bottoms in the solenoid assembly, it presses switch contact assembly against the motor terminal stud and the battery terminal stud inside the solenoid assembly case. The power circuit is completed to the starter motor when this switch is closed and the solenoid pull-in winding is shorted. The solenoid hold-in winding maintains switch closed against spring pressure until start control circuit is opened.

d. At any given armature position, power applied to the starter motor will provide current flow simultaneously through each of three paths to ground. Each path routes current through one pair of series-connected field coils, through a brush-to-commutator contact, through two armature windings, and through the brush-to-commutator contact of an adjacent brush to ground. When current flows, each path generates an N and an S magnetic pole on the armature and an N and S magnetic pole on a pair of adjacent pole shoes in the frame assembly. Magnetic fields between these armature poles and pole shoes provide the starter's output torque.

e. At output end of the starter, drive torque of the armature shaft is coupled through the clutch rolls (no slip direction) to the drive pinion.

f. If the drive pinion could not engage a drive gear because of gear tooth misalinement, the helical spline would be pushed through the drive pinion by overpowering the compression spring as necessary. This movement along the helical spline allows switch contacts in the solenoid assembly to be closed and armature to start rotation. The compression spring engages drive pinion with drive gear as soon as gear tooth alinement permits.

g. The overrunning action provided by the clutch rolls prevents an engine from driving the armature. At normal engine speeds, the ratio between the engine drive gear and the starter drive pinion would produce destructive rates of rotation for the starter armature were it not for the protection afforded by the overrunning clutch.

h. Operator should not hold start switch on (hold-in winding energized) longer than 30 seconds at one time and should allow two minutes for starter to cool before engaging the starter again. Start switch should be released (turned off) as soon as an engine starts.

i. When start circuit is opened and while solenoid switch is still closed, solenoid windings are connected in a series circuit. Current flows through pull-in winding in a reverse direction to that in hold-in winding. This makes mutually canceling magnetic fields. With overall solenoid magnetic field thus neutralized, the return spring pressures open the solenoid switch and pull drive clutch assembly away from pinion-engaged position.

END OF WORK PACKAGE

CHAPTER 2

MAINTENANCE INSTRUCTIONS

REPAIR PARTS, SPECIAL TOOLS, AND SUPPORT EQUIPMENT 0004 00

THIS WORK PACKAGE COVERS:

Repair Parts, Special Tools, and Support Equipment

COMMON TOOLS AND EQUIPMENT

a. For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

b. GS maintenance will have a 500 Ampere Test Stand which may be used for operation and test of starter assembly. Refer to TM 9-4910-458-12 for information about the test stand.

c. Do not perform any stall test on these starter assemblies. Stall torque and current measurements are not needed to evaluate performance.

SPECIAL TOOLS

No special tools are required to perform the maintenance procedures described in this manual.

REPAIR PARTS

Repair parts are listed and illustrated in WP 0015 00 of this manual.

ILLUSTRATED LIST OF MANUFACTURED ITEMS

Manufactured items are listed and illustrated in WP 0013 00 of this manual.

a. Brush Spring Lifter. The brush spring lifter is used to raise the brush sprinq in order to remove a brush.

b. Spring Wind Tool. The spring wind tool is used when a new brush spring is to be installed in a brush holder.

c. Leak Test Fitting. A leak test fitting is used for applying air pressure during the starter waterproof testing.

END OF WORK PACKAGE

TROUBLESHOOTING INSTRUCTIONS 0005 00

THIS WORK PACKAGE COVERS:

Troubleshooting Instructions and Malfunction/Corrective Action Table

TROUBLESHOOTING INSTRUCTIONS

a. General. The troubleshooting procedures check for improper operation as reported and helps find defective components. These procedures are also used when malfunction is not specified to determine the kind of repair needed.

1) Probable causes and corrective actions for most starter malfunctions are listed in Table 2-1. Probable causes for each malfunction are listed from most probable to least probable.

2) When condition of a starter is unknown, specific malfunctions can be looked for in the sequence presented by Table 2-1. Whether a malfunction is found in this manner or by verification of a reported failure, the corrective action should be taken before further operation of the starter, which might increase damage. Only the more common malfunctions are listed in Table 2-1.

b. Troubleshooting Procedure. If a specific malfunction described can be found in Table 2-1, verify and determine the actual cause. Partial disassembly and/or specific tests may be required as noted by the column entries for that malfunction. Correct defects as applicable.

1) Test Stand Operation. With the starter supported on a suitable test bench or stand (fig. 2-1), check armature for freedom to rotate by prying on drive pinion as necessary to turn armature counterclockwise as viewed from drive end.

2) Solenoid Shift Check. Connect power source or battery (fig. 2-2) to the solenoid terminals as indicated. Briefly close, then open the switch. Drive clutch assembly should shift in response to switch closure and return when switch is opened.

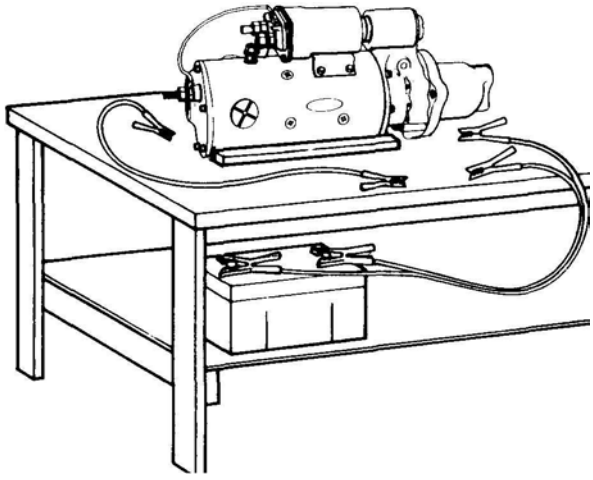


Figure 2-1. Simple Test Bench Setup

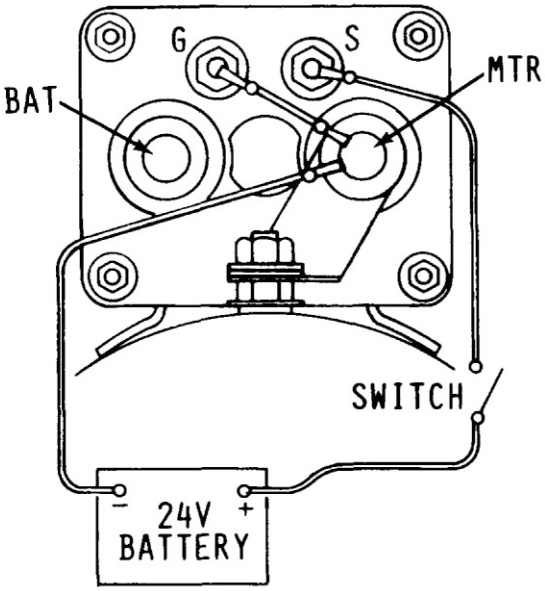


Figure 2-2. Solenoid Shift Test Circuit

TROUBLESHOOTING INSTRUCTIONS - CONTINUED 0005 00

3) No-Load Speed and Current. Connect starter to power supply with circuit equivalent to Figure 2-3. When the switch is closed, the armature should rotate at 5500 to 7500 rpm and current should be in the range of 95A to 120A when applied voltage is at least 20 VDC.

NOTE

Voltage higher than 20 VDC will cause higher rpm in cause a starter, but current draw will remain about the same because counter-electromotive force (CEMF) will increase.

4) Brush Lead Tightening. Low speed and low current are a symptom of high internal resistance which may be caused by loose attaching screws for brush leads. Torque loose brush lead screws as shown in Figure 2-4 to 18-24 lb-in (2.0 to 2.7 N•m).

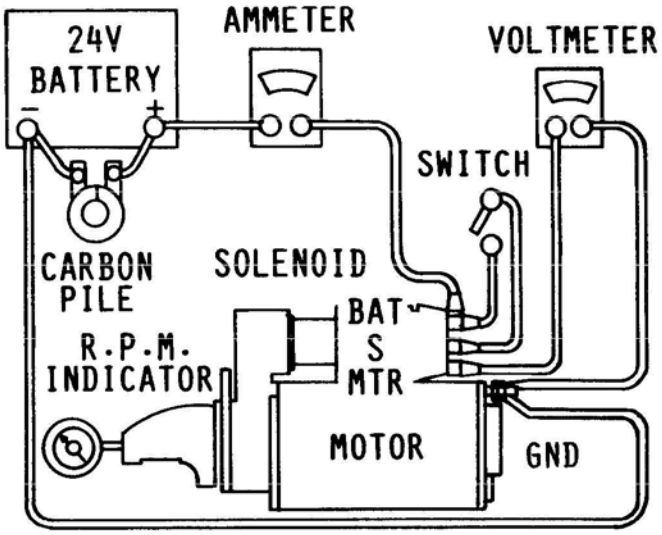


Figure 2-3. No-Load Test Circuit

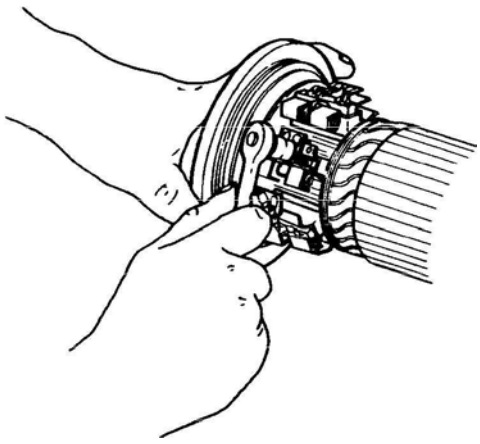


Figure 2-4. Brush Lead Tightening

5) Temporary Lubrication of Bearings. If starter produces excessive noise and a lack of lubrication is indicated, temporary lubrication of bearing(s) can be provided by punching a 1/16 inch diameter hole in seal plug over bearing wick (fig. 2-5). Use an oiler to inject about one-quarter fluid ounce of SAE No. 20 (non-detergent) engine oil. Allow five minutes for oil to penetrate bearing.

6) After allowing time for oil penetration, run starter again to see if lubrication reduces noise. Any seal plug punctured in this manner must be replaced before the starter is put back in ready-for-use status, but temporary lubrication can help the analysis of bearing condition during troubleshooting.

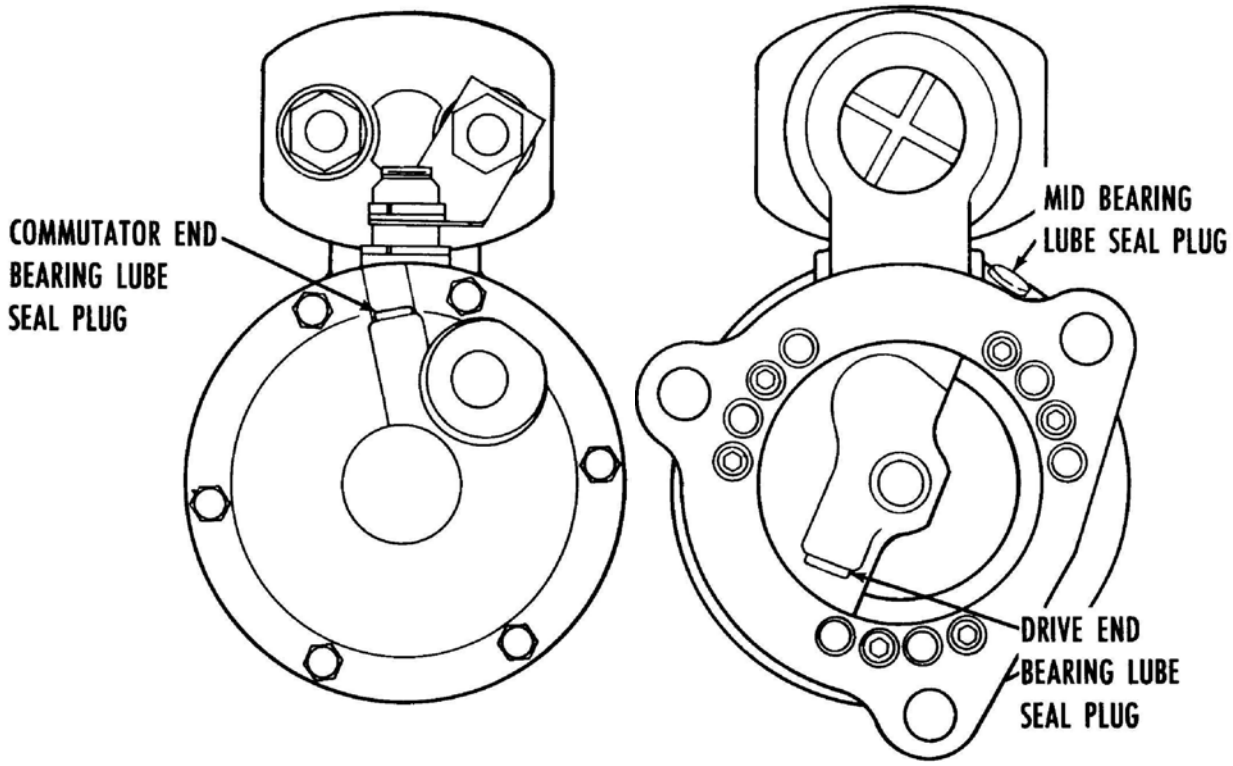


Figure 2-5. Punching Hole for Temporary Lubrication

7) Housing Attaching Screws. If starter produces excessive noise because a housing is not securely fastened, check and/or torque attaching screws (fig. 2-6) to 144-192 lb-in (16.3 to 21.7 N•m).

8) Shift Lever. Remove the inspection plug for access to shift lever adjusting nut (fig. 2-7) if looseness is indicated.

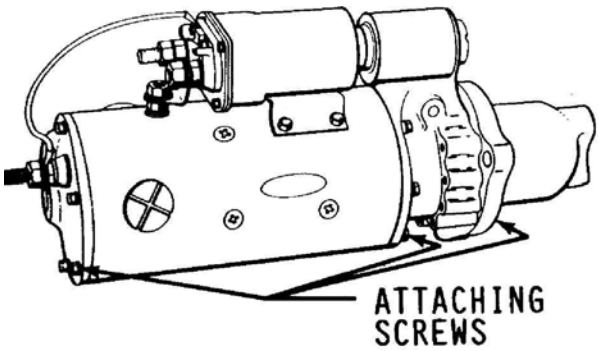


Figure 2-6. Location of Housing Attaching Screws

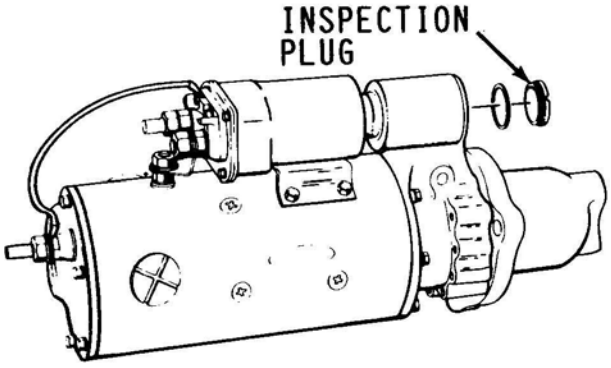


Figure 2-7. Access to Shift Lever Adjust Nut

9) Separate lever housing with drive end housing with assembled parts (fig. 2-8) to check for suspected binding in shift lever or drive clutch assembly by manually moving solenoid plunger.

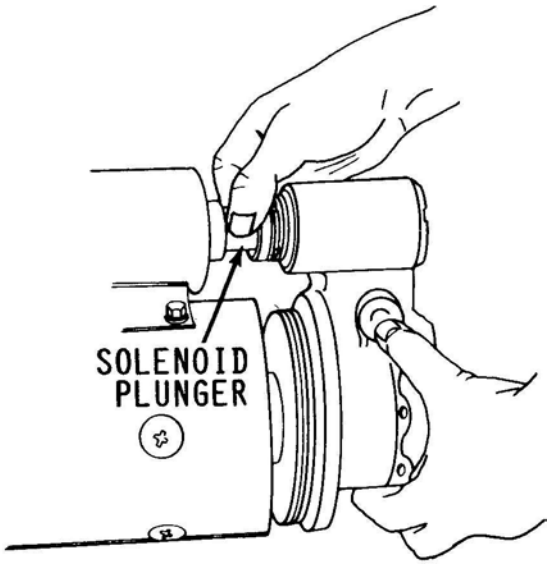


Figure 2-8. Access to Solenoid Plunger

TROUBLESHOOTING INSTRUCTIONS - CONTINUED 0005 00

10) Clutch Override. A clockwise (viewed from drive end) torque applied quickly to the drive pinion by thumb pressure when armature is at rest (fig. 2-9) will check overrunning clutch. Drive pinion should rotate without rotating armature.

11) Brush Arcing. When armature speed and starter current are both less than minimums indicated in preceding step (3), check for excessive arcing of brushes (Table 2-1; Malfunction No. 8) during a no-load run.

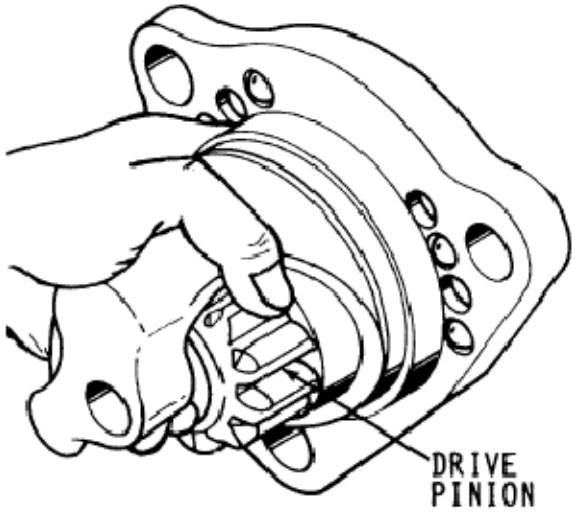


Figure 2-9. Override Check

12) Remove three brush inspection plugs (fig. 2-10) and look into motor through each opening. Any unusual arcing seen at brush contact surface can be due to one or more of the causes listed in Table 2-1.

13) If arcing is localized to an area near a particular inspection hole, check for worn, binding, or broken brushes and/or a defective brush spring.

14) Commutator problems should produce arcing in all three areas seen through inspection holes.

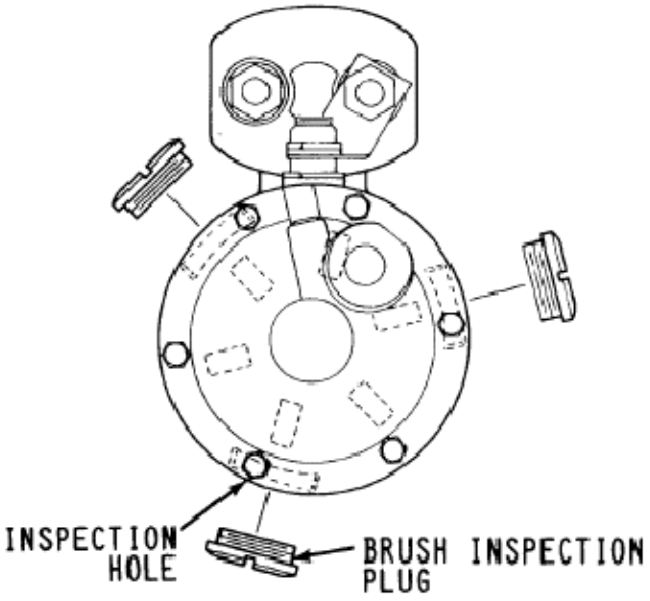


Figure 2-10. Inspection Holes for Visual Check for Excessive Arcing

TABLE 2-1. TROUBLESHOOTING

MALFUNCTION	PROBABLE CAUSE(S)	CORRECTIVE ACTION
1. Starter fails to operate or turns slowly.	a. Starter frozen.	Disassemble starter and check for bind in bearings, bent armature shaft, or loose pole shoe. Repair as necessary.
	b. Defective solenoid assembly	Check for operation of solenoid by placing a jumper from BAT terminal to S terminal. If the solenoid does not operate, replace solenoid assembly.
	c. Worn brushes or defective springs.	Remove commutator end plate and inspect brushes. Check brush spring tension. Install new brush kit if parts are defective.
	d. Worn or pitted commutator.	Remove armature and inspect commutator. Resurface commutator or replace armature if defective.
	e. Eccentric commutator.	Remove armature and check eccentricity. Resurface commutator or replace armature.
	f. Shorted or grounded commutator.	Remove commutator end plate and check for evidence of excessive arcing. If arcing is evident, remove armature and check for grounds or shorts. Replace armature, if defective
	g. Grounded field windings.	Inspect field windings. Replace windings if defective.
2. Low speed and low current.	a. High internal resistance.	Remove commutator end plate and tighten brush leads.
	b. Poor brush contact.	Remove commutator end plate and inspect brushes and commutator. Install new brush kit or resurface commutator.
3. Low speed and high current.	a. Faulty armature.	Remove commutator end plate and inspect commutator for evidence of excessive arcing. If indicated, remove armature and check for grounds or shorts. Replace armature, if defective.
	b. Armature drag.	Disassemble starter and inspect bearings and armature. Repair as required.

TABLE 2-1. TROUBLESHOOTING

MALFUNCTION	PROBABLE CAUSE(S)	CORRECTIVE ACTION
4. Starter produces excessive noise when operated.	a. Lack of lubrication.	Lubricate the bearings.
	b. Defective bearings.	Disassemble starter and replace bearings, if defective.
	c. Loose pole shoes.	Tighten loose pole shoe screws.
	d. Loose housings.	Tighten all housing attaching screws.
5. Starter drive clutch fails to shift.	a. Defective solenoid assembly.	Check for operation of solenoid by placing a jumper from BAT terminal to S terminal. If solenoid does not operate, replace solenoid assembly.
	b. Loose adjustment nut.	Remove inspection plug and check adjustment nut. If loose, replace and adjust pinion clearance.
	c. Binding in shift lever or drive clutch.	Remove lever housing assembly and check for defective lever, shaft or drive clutch. Replace as required.
6. Pinion will not override.	Defective drive clutch assembly.	Remove defective drive clutch assembly and install a replacement part.
7. Starter vibrates during operation.	Worn or damaged bearings.	Remove commutator end plate and armature. Inspect brushes and check brush spring tension. Install new brush kit if any of these parts are defective.
8. Excessive arcing of brushes.	a. Worn, binding, or broken brushes or defective springs.	Remove commutator end plate and armature. Inspect commutator. Clean commutator or resurface commutator as necessary.
	b. Commutator is scored, pitted, or dirty.	Remove commutator end plate and armature. Inspect commutator. Clean commutator or resurface commutator as necessary.
	c. Eccentric commutator.	Remove armature and check eccentricity. Resurface commutator or replace armature.
	d. Commutator mica not undercut properly.	Remove armature and inspect commutator. Undercut mica. if necessary.

TABLE 2-1. TROUBLESHOOTING

MALFUNCTION	PROBABLE CAUSE(S)	CORRECTIVE ACTION
	e. Shorted or grounded field windings.	Inspect field windings. Replace windings if defective.
	f. Shorted or grounded armature windings.	Remove armature and check for grounds or shorts. Replace armature, if defective.

END OF WORK PACKAGE

CHAPTER 3

MAINTENANCE PROCEDURES

GENERAL MAINTENANCE INSTRUCTIONS 0006 00

THIS WORK PACKAGE COVERS:

General Maintenance Instructions

PURPOSE

This chapter contains information for general cleaning; disassembly; cleaning, inspection, and repair of component parts; assembly; operational testing; and storage of starter assemblies after they have been removed from the engine.

APPLICATION

All procedures in this chapter apply to both starter configurations covered by this manual except where identified as for 6-brush or 12-brush starter.

ORGANIZATION

Each maintenance work package described in this chapter will be organized in the following manner:

a. This Work Package Covers. Provides a description of the scope of the work package.

b. Initial Setup. lists the information you will need before starting the procedure, such as:

   1) Tool requirements.

   2) Material and supplies requirements.

   3) Personnel requirements.

   4) Equipment condition.

c. Procedure. Outlines the process for performing the task in step-by-step sequence.

ILLUSTRATIONS

Each illustration, used to describe a procedural step, will be located following that step(s).

CONVERSIONS

Conversion to a 6-brush starter is mandatory when a 12-brush starter is disassembled for maintenance. Use Kit No. 12314630 for converting starter part number 1109972, and use Kit No. 12314632 for converting starter part number 1990272. Kits will contain conversion instructions.

REMOVAL AND INSTALLATION

Refer to TM 9-2815-220-34 for instructions covering the removal and installation of the starter.

END OF WORK PACKAGE

GENERAL CLEANING 0007 00

THIS WORK PACKAGE COVERS:
General Cleaning

INITIAL SETUP:

Tools and Special Tools
General mechanic's tool kit (item 1, WP 0017 00)

Materials/Parts
Rag (item 1, WP 0016 00)
Solvent (item 3, WP 0016 00)

Materials/Parts - Continued
Tape (item 4, WP 0016 00)
Sandpaper (item 5, WP 0016 00)
Brush (item 12, WP 0016 00)
Goggles (item 13, WP 0016 00)
Gloves (item 14, WP 0016 00)

GENERAL CLEANING

a. Using tape seal the openings for the armature shaft, bearing in drive end housing, and pinion access.

WARNING

Dry-cleaning solvent (P-D-680) used to clean parts, is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes. Do not breathe vapors. Do not use near open flame or excessive heat. Do not smoke when using solvent. Failure to do so could cause SERIOUS INJURY. If you become dizzy while using cleaning solvent, get fresh air immediately, and if necessary, get medical attention. If contact with skin or clothes is made, flush thoroughly with water. If the solvent contacts your eyes, flush with water immediately, and obtain medical aid (ref. FM 4-25.11)

CAUTION

Never use a wire brush or steel blade scraper on exterior surfaces of the starter.

b. Using a bristle brush, putty knife, and solvent, remove dirt, oil, and other contaminants from all exterior surfaces.

c. Use a clean rag moistened with solvent to clean hard to reach areas.

WARNING

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

d. Blow cleaned surfaces dry with compressed air.

e. Cleaning Instructions for Specific Components.

1) Frame Assembly. If starter frame assembly has not been completely disassembled, clean field coils and frame thoroughly with a rag moistened with solvent. Be careful that protective insulation coating is not damaged.

2) Armature. Remove loose particles from armature with compressed air. Wipe surfaces with a clean rag moistened with solvent. Clean commutator surface lightly with No. 2/0 sandpaper, then remove all traces of dust with low pressure compressed air.

3) Brush Holder Assembly. If the brush holder assembly has not been disassembled, clean holders, springs, and screws with a soft brush dipped in solvent. Use a clean rag moistened with solvent to clean insulation and plates.

4) Solenoid Assembly. Clean parts of the solenoid assembly with a clean rag moistened with solvent.

GENERAL CLEANING - CONTINUED 0007 00

5) Brushes. If brushes will be re-used, clean by wiping with a clean, dry rag. Do not permit solvent to contact brushes.

6) Drive Clutch Assembly. Do not immerse in solvent. Clean exterior surfaces with a clean rag moistened with solvent.

END OF WORK PACKAGE

DISASSEMBLY OF THE STARTER ASSEMBLY 0008 00

THIS WORK PACKAGE COVERS:

Disassembly

INITIAL SETUP:

Tools and Special Tools

General mechanic's tool kit (item 1, WP 0017 00)
Spring tester 0–10 lbs (item 2, WP 0017 00)
Hacksaw blade (item 3, WP 0017 00)
Brush spring lifter (item 4, WP 0017 00)
Metal scriber (item 5, WP 0017 00)
Bearing puller set (item 6, WP 0017 00)
Retaining ring pliers (item 7, WP 0017 00)
Drill, electrical, portable ¼ in. (item 8, WP 0017 00)
Bit, drill, 5/32 (item 9, WP 0017 00)
Screw, tapping, thread forming (item 10, WP 0017 00)
Holder, inserted hammer face (item 11, WP 0017 00)
Face, hammer, inserted (item 12, WP 0017 00)
Face, hammer, inserted (item 13, WP 0017 00)
Magnifier (item 14, WP 0017 00)
Extension light (item 15, WP 0017 00)
Caliper, vernier 0–6 in. (item 16, WP 0017 00)
Caliper, micrometer 1–2 in. (item 17, WP 0017 00)
Caliper, micrometer 0–1 in. (item 25, WP 0017 00)
Caliper, micrometer 2–6 in. (item 26, WP 0017 00)
Telescope gage set (item 18, WP 0017 00)
Dial indicator (item 19, WP 0017 00)
Wrench set, socket ¼ in. drive (item 20, WP 0017 00)

Materials/Parts

Clean rags (item 1, WP 0016 00)
Solvent (item 3, WP 0016 00)
Sandpaper (item 5, WP 0016 00)
Hard bristle brush (item 12, WP 0016 00)
Goggles (item 13, WP 0016 00)
Rubber gloves (item 14, WP 0016 00)
Wire probe (item 15, WP 0016 00)
Wood block (item 9, WP 0016 00)

Equipment Conditions

Starter on workbench

Equipment

Growler fixture
Lathe

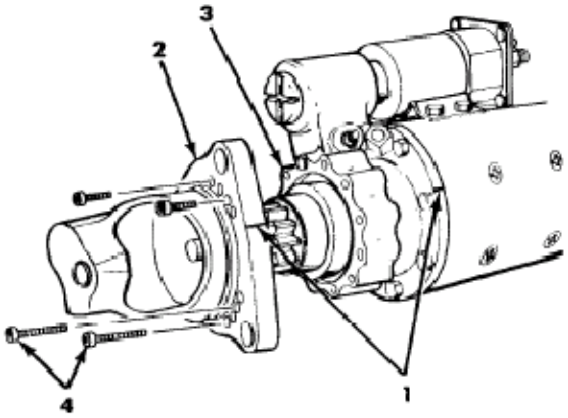
DISASSEMBLY OF THE STARTER ASSEMBLY - CONTINUED 0008 00

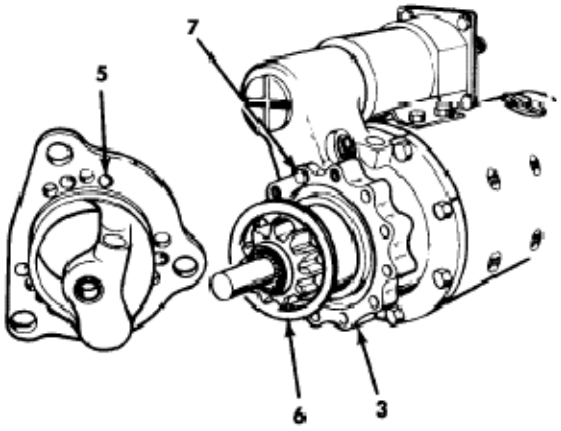
NOTE

Before performing disassembly of the starter assembly, read WP 0007 00 GENERAL CLEANING.

Disassembly

1. Disassembly of Drive End Housing Assembly.
   a. Scribe two aligned marks (1) across drive end housing (2) and lever housing (3) for realignment during assembly.
   b. Remove six internal wrenching bolts (4) and pull drive end housing assembly off starter.
   c. Remove six rubber ball seals (5) from unused boltholes in drive end housing.
   d. Remove and discard gasket (6) from lever housing (3).
   e. Remove red rubber plug (7) from lever housing (3).





   f. Drill a 5/32 inch hole near the center of exposed surface of oil reservoir cap (8) and thread a thread forming tapping screw (9) into this hole to use as a puller. Remove cap and wick (10) and discard.

NOTE

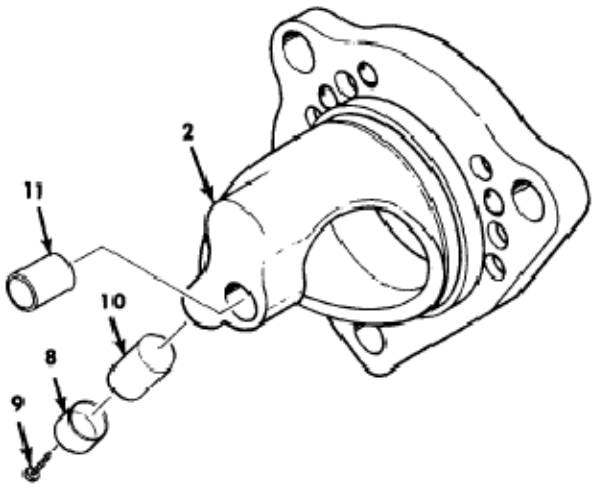
Do not remove sleeve bearing to check outside diameter and housing bore diameter unless bearing is loose in housing exceeding the 0.0040 to 0.0060 inch interference fit limits.

   g. Using puller from bearing puller set, remove sleeve bearing (11) from drive end housing (2). Replace if sleeve bearing outside diameter exceeds 0.754 to 0.755 inch.
   h. Inspect drive housing (2) for cracks and distortion. Replace housing if defective.

NOTE

When inspecting for cracks, use an extension light and a magnifying glass.

   i. If sleeve bearing was removed during disassembly, check bearing bore in housing. Replace housing if bore dimension exceeds 0.7490 to 0.7500 inch.



DISASSEMBLY OF THE STARTER ASSEMBLY - CONTINUED 0008 00

j. Inspect the housing for burs, scratches, and nicks on machined surfaces. Replace if defects cannot be repaired.

k. Inspect threads in tapped holes in housing for damaged threads. Replace housing if the threads are stripped.

l. Check inside diameter of sleeve bearing. Replace bearing if it exceeds 0.624 to 0.627 inch.

m. Inspect sleeve bearing for rough spots, score marks, scratches, and nicks. Replace if defective.

2. Disassembly of Commutator End Plate Assembly.

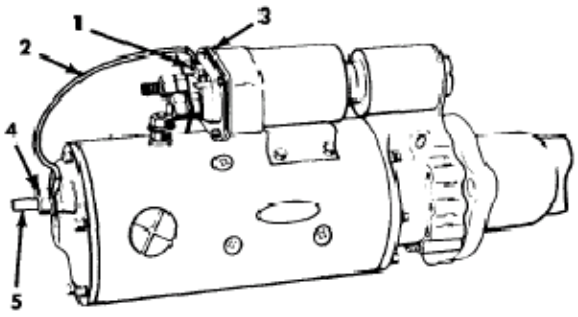
NOTE

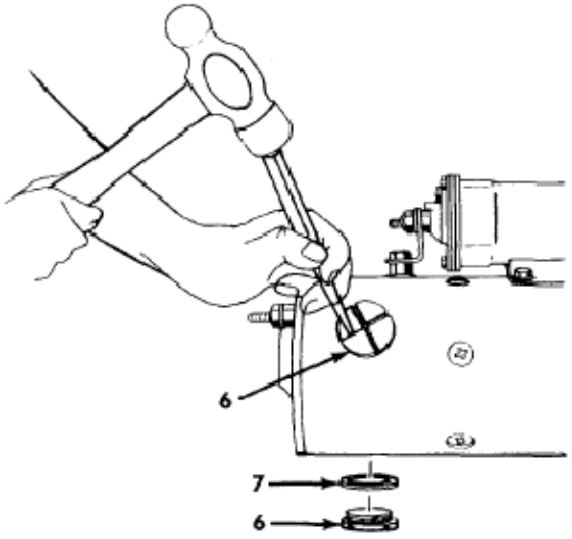
There are two solenoid assemblies 1119872 (early) and 1115563 (late).

a. Remove washer nut (1) and electrical lead assembly (2) from terminal G of solenoid assembly (3). On early model solenoid assembly, remove lower right nut and electrical lead assembly from terminal plate.

b. Remove washer nut (4) and electrical lead assembly from ground terminal stud (5).

c. Use a drive pin punch and hammer to tap loose four machine thread plugs (6). Remove plugs and gaskets (7). Discard gaskets.





DISASSEMBLY OF THE STARTER ASSEMBLY - CONTINUED 0008 00

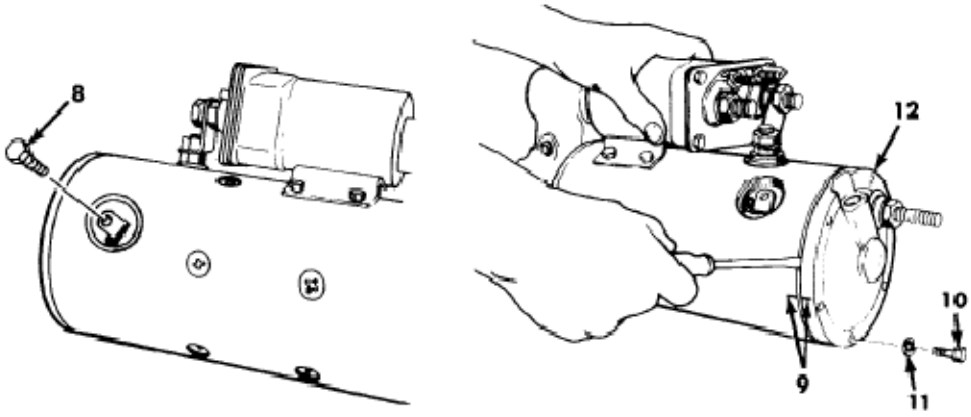
NOTE

The 12-brush starters will have pan head screws attaching field leads.

d. Using a 1/4 inch socket tool, remove three hex head screws (8), which attach field leads.

e. Scribe marks (9) on the frame and end plate for realignment at assembly.

f. Remove six hex head cap screws (10) and lock washers (11). Discard lockwashers.

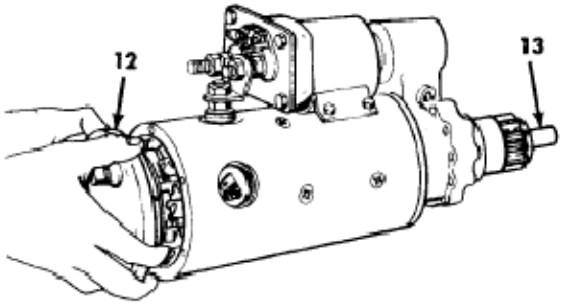


g. Using a screwdriver, pry end plate (12) away from frame.

h. Push drive end (13) of armature shaft inward as necessary while pulling end plate (12) away from frame.

NOTE

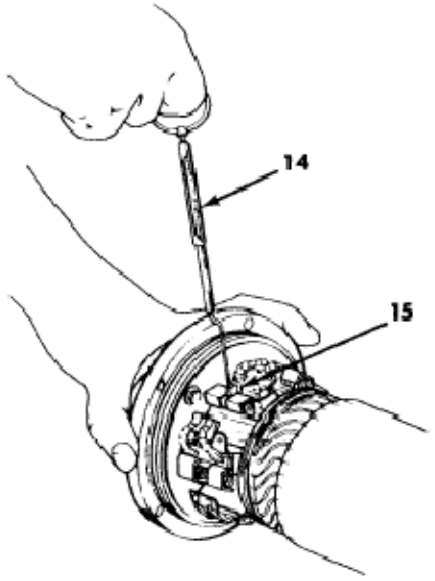
Commutator on armature must be under brushes for tension measurement.



DISASSEMBLY OF THE STARTER ASSEMBLY - CONTINUED 0008 00

i. Use a 0-10 lb spring tester (14) to measure and record force needed to lift each brush tension spring (15) just off its brush.

j. Mark for replacement any brush spring (15) with tension less than 7.5 lb.



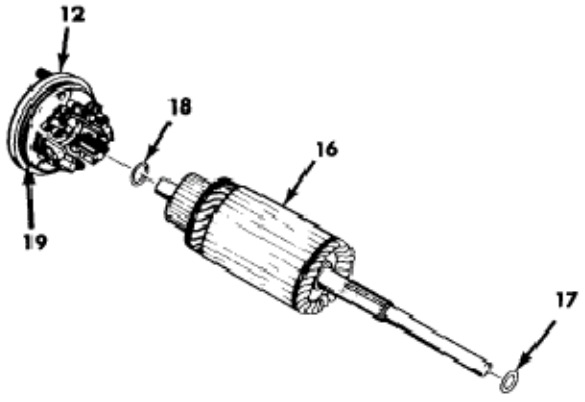
k. With armature (16) clear of frame assembly, remove armature from commutator end plate assembly

l. Remove spacer (17) and thrust washer (18) from armature (16).

m. Inspect thrust washer and spacer for cracked or deformed condition. Replace if defective.

n. Replace washer or spacer if thickness does not conform to 0.0570 to 0.0670 inch for the washer and 0.1800 to 0.1960 inch for the spacer.

o. Remove preformed packing (19) from end plate (12). Discard packing.



DISASSEMBLY OF THE STARTER ASSEMBLY - CONTINUED 0008 00

p. Remove six hex head screws (20), which attach brush leads to holders (21).

NOTE

- The 12-brush starters will have 9 pan head screws to remove. Three of these screws were removed to disconnect field leads.
- If brush is serviceable and will be re-installed at assembly, mark brush and holder so that brush will be in original location.

q. Using brush spring lifter, raise spring and slide brush (22) down through holder (21).

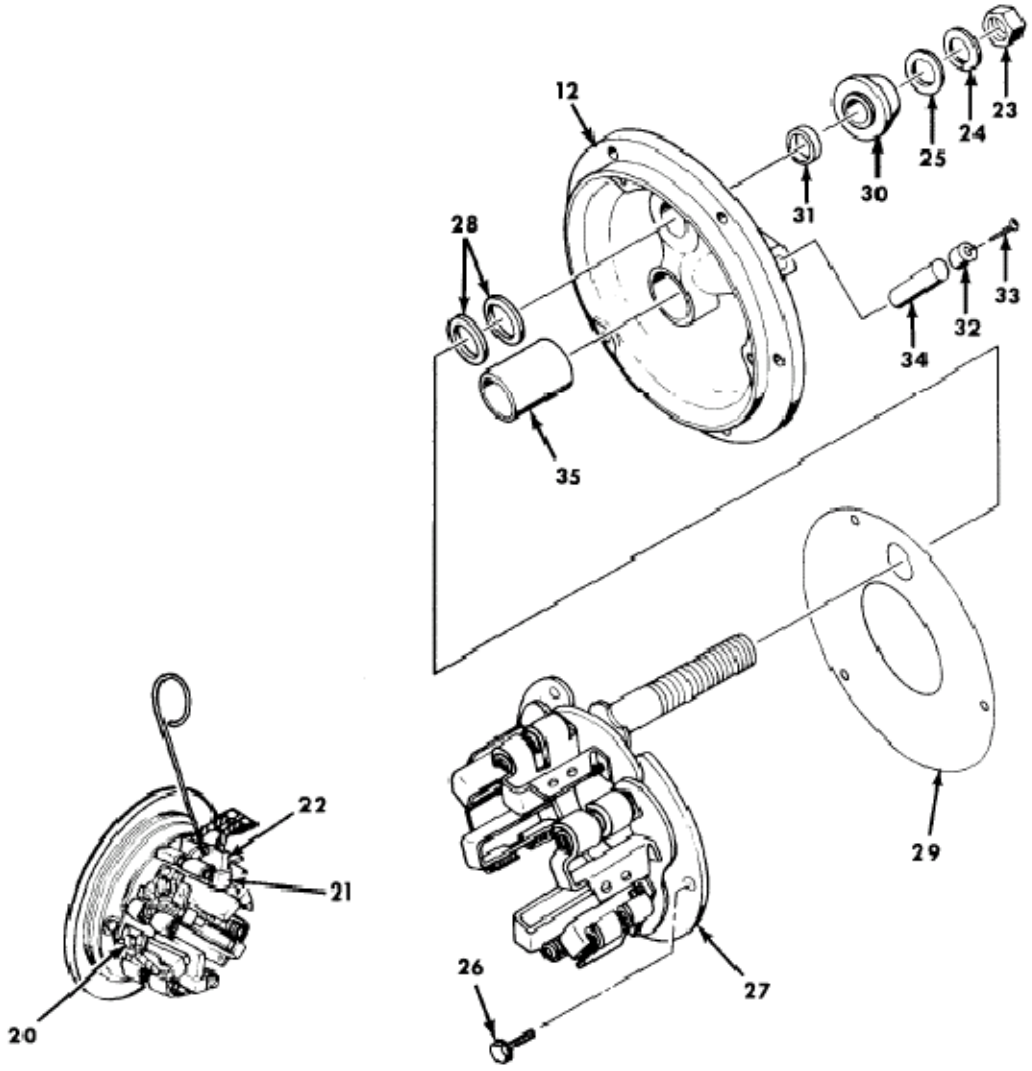
r. Remove nut (23), lock washer (24), and flat washer (25). Discard lock washer.

s. Remove three screws (26). Using a soft plastic hammer, tap to remove brush holder assembly (27) from end plate assembly (12).

t. Remove two washers (28) and insulator (29).

u. Remove terminal stud insulator (30) and insulating bushing (31) from end plate (12).

v. Drill a 5/32 inch hole near center of exposed surface of oil reservoir cap (32) and thread a thread forming tapping screw (33) into this hole to use as a puller. Remove cap (32) and wick (34) and discard.



DISASSEMBLY OF THE STARTER ASSEMBLY - CONTINUED 0008 00

NOTE

Do not remove sleeve bearing to check outside diameter and housing bore diameter unless bearing is loose in housing exceeding the 0.0040 to 0.0060 inch interference fit limits.

w. Using a puller from bearing puller set, remove sleeve bearing (35) from end plate (12). Discard bearing.

x. Inspect commutator end plate for cracks and distortion. Replace plate if defective.

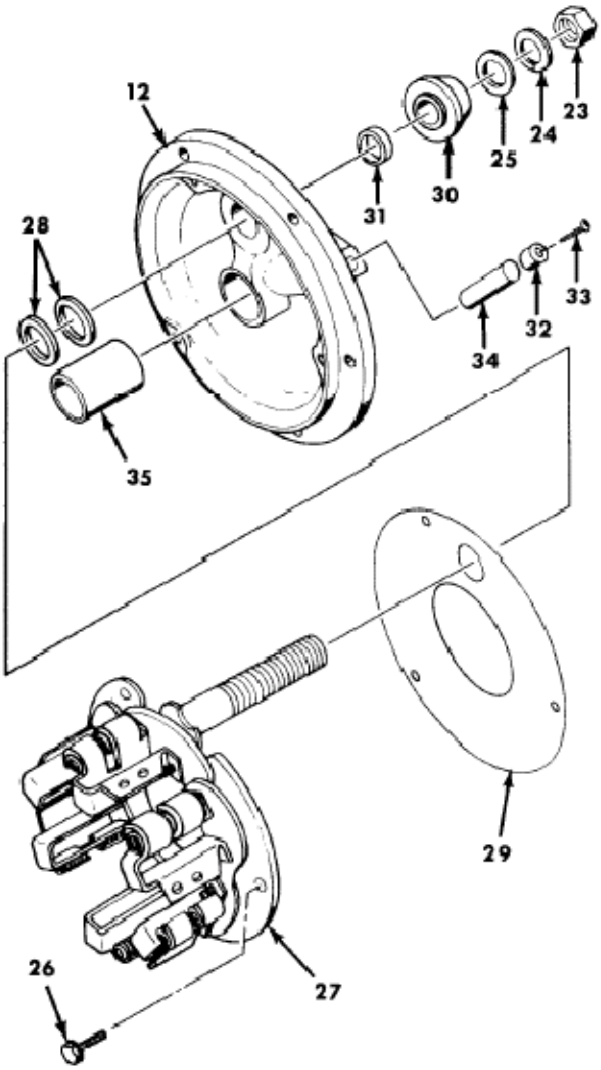
y. Check bearing bore in end plate. Replace end plate if bore does not conform to 0.8740 to 0.8750 inch wear limits.

z. Inspect end plate for scratches, burs, and nicks on machined surfaces. Replace if defects cannot be repaired.

aa. Inspect threads in tapped holes in end plate for damage. Replace the end plate if threads are stripped.

ab. Check inside diameter of sleeve bearing. Replace bearing if it does not conform to 0.686 to 0.689 inch limits.

ac. Inspect sleeve bearing for rough spots, score marks, scratches, and nicks. Replace if defective.



DISASSEMBLY OF THE STARTER ASSEMBLY - CONTINUED 0008 00

3. Armature Disassembly

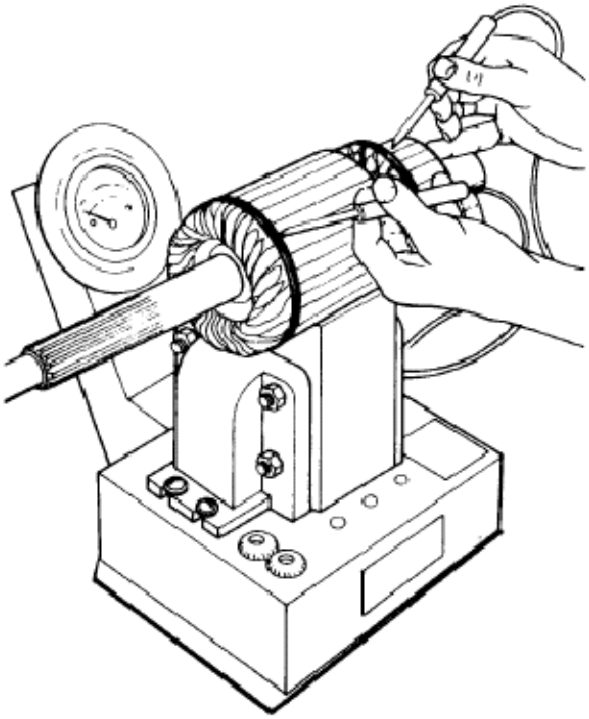
   a. Check armature shaft and commutator. Replace if armature shaft bearing diameter exceeds 0.6835 to 0.6845 inch at commutator end and 0.6215 to 0.6230 inch at drive end. The diameter of the armature shaft bearing in the lever housing shall not exceed 0.8225 to 0.8240 inch.

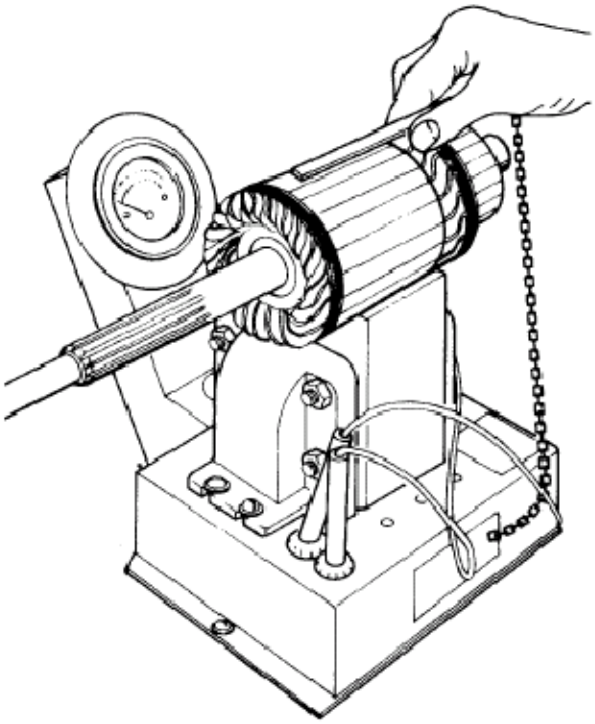
NOTE

Low resistance of armature windings and interconnection through commutator bars make any and all commutator bars essentially the same circuit for this test.

   b. 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 bars. If the test light glows, the armature is grounded and must be replaced.

   c. Inspect armature for short circuits using a growler fixture. Place the armature in growler. Hold a thin strip of steel, such as a hacksaw blade on the armature. While holding the steel strip in position, rotate the armature slowly. A short circuit will cause the strip to vibrate. If a short circuit is found, replace the armature.





DISASSEMBLY OF THE STARTER ASSEMBLY - CONTINUED 0008 00

d. Commutator diameter on armature must be within 2.3080 to 2.3180 inches. Inspect armature shaft and commutator for eccentricity with a lathe or "V" blocks and a dial indicator. If the eccentricity exceeds 0.0050 TIR, the commutator must be resurfaced provided it will not be cut below 2.1930 inch diameter limits.

e. Inspect armature shaft splines for wear. Replace the armature if the splines are defective.

f. 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.

4. Disassembly Brush Holder Assembly.

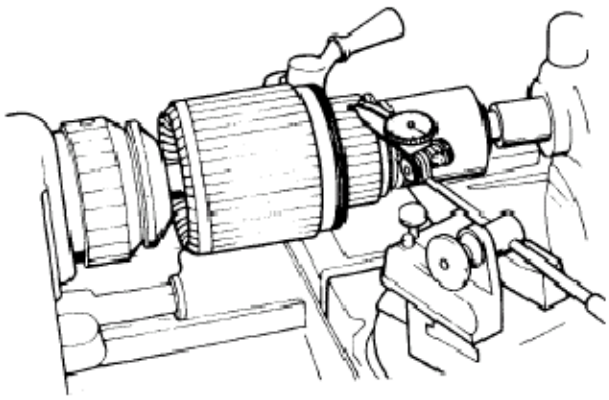
WARNING

Compressed air used for cleaning purposes will not exceed 30 psi. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

NOTE

When disassembling a 12-brush starter and conversion to 6-brush will be made at assembly, do not disassemble brush holder assembly.

a. Remove buildup dust and dirt using compressed air prior to test.



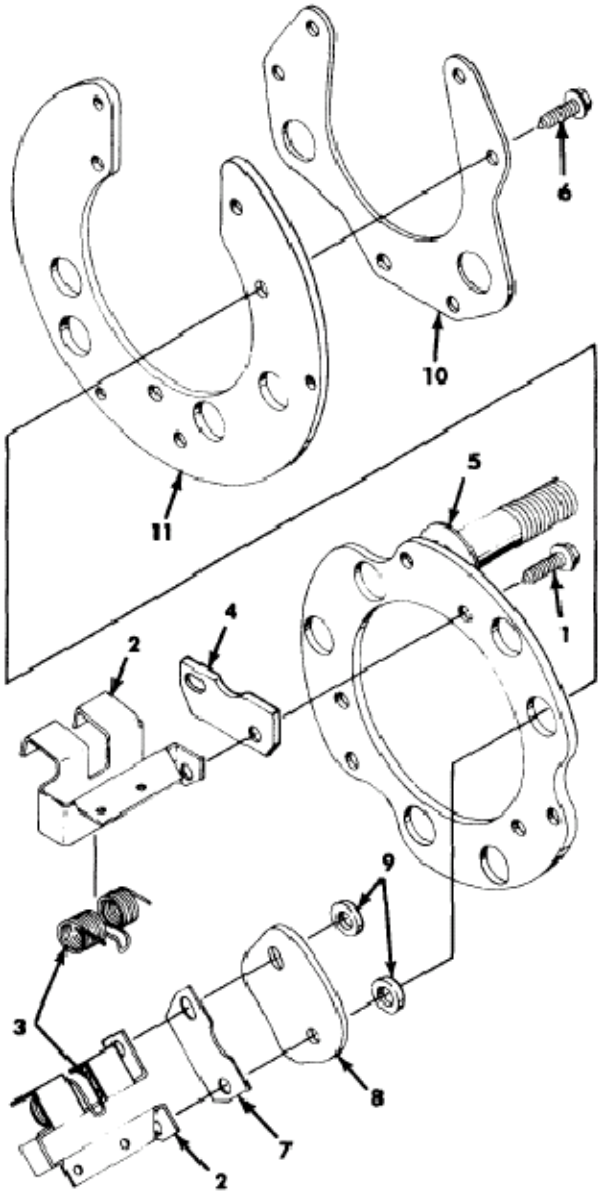
DISASSEMBLY OF THE STARTER ASSEMBLY - CONTINUED 0008 00

b. Using multimeter, check continuity on each brush holder terminal. Every other terminal should read a continuity or ground respectively.

c. Check brushes and springs for cracks or breaks. Check brushes and spring tension for conformity to dimension limits. New brush length shall be within 0.750 to 0.780 inch. Field wear limit is .375 inch. Spring tension shall be a minimum of 7.5 lb (at working deflection). If any brushes or springs are defective, replace entire set with a brush kit.

d. Remove six grounded brush holder washer screws (1) and separate three brush holders (2) with springs (3) and three plates (4) from terminal and plate assembly (5).

e. Remove six insulated brush holder washer screws (6) and separate three brush holders (2) with springs (3), three plates (7), three insulators (8), six insulator washers (9), conductor (10), and brush plate insulator (11) from terminal and plate assembly (5).



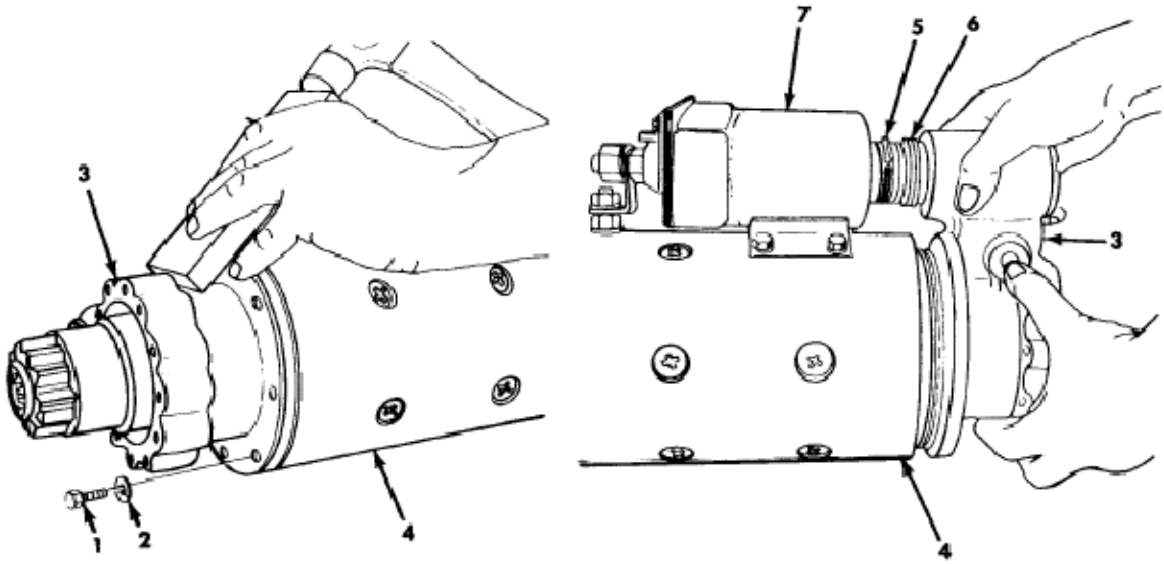
DISASSEMBLY OF THE STARTER ASSEMBLY - CONTINUED 0008 00

5. Disassembly Drive Clutch And Lever Housing Assemblies.
   a. Remove seven hex head cap screws (1) and lock washers (2) which attach lever housing assembly (3) to starter frame (4). Discard lockwashers.
   b. Use a wood block and hammer to start separation of lever housing (3) from starter frame (4).
   c. Loosen hose clamp (5) and work rubber bellows (6) off solenoid assembly (7) as lever housing assembly (3) is pulled away from starter frame (4).

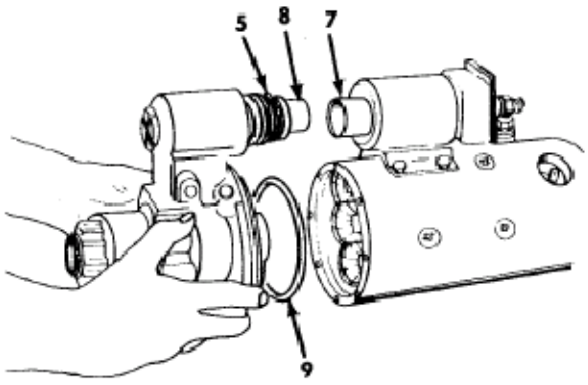
WARNING

Hold Bendix drive to prevent injury.

   d. Inspect bellows for tears punctures and deterioration. Replace bellows if defective.



   e. When solenoid plunger (8) is out of solenoid assembly (7), remove hose clamp (5). Remove preformed packing (9) from lever housing. Discard packing.
   f. Inspect solenoid plunger for cracks and distortion. Replace plunger if defective.
   g. Inspect plunger rod threads. Replace plunger if threads are stripped.



DISASSEMBLY OF THE STARTER ASSEMBLY - CONTINUED 0008 00

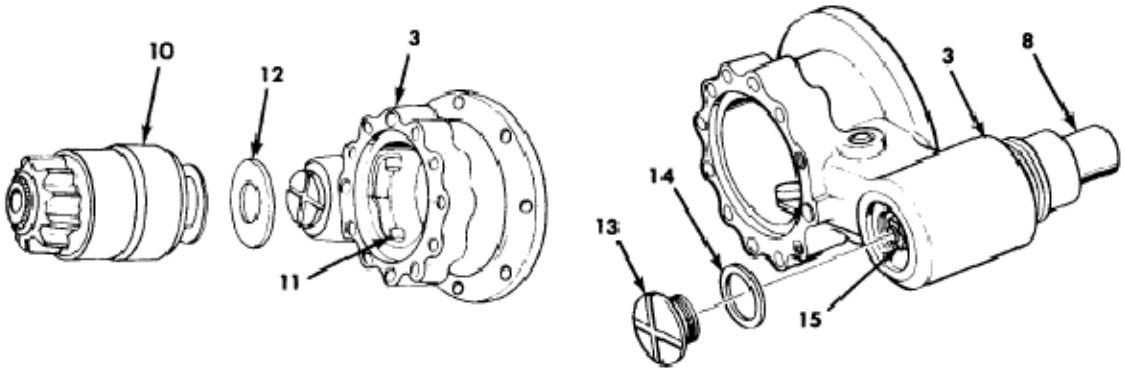
h. Tilt drive clutch assembly (10) as necessary to disengage from fork of shift lever (11) and remove from lever housing (3).

i. Remove nonmetallic washer (12) from lever housing (3).

j. Remove inspection plug (13) and gasket (14) from lever housing (3). Discard gasket.

k. Hold plunger (8) to prevent rotation and use a socket wrench to loosen self-locking nut (15) on end of plunger.

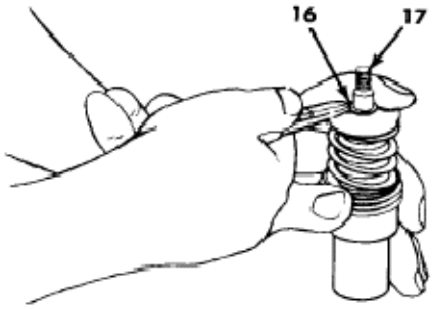
l. Remove hex self-locking nut (15) and pull assembled plunger (8) out of lever housing (3).



WARNING

Apply downward pressure on recessed washer when removing retaining ring to prevent spring from releasing.

m. Use retaining ring pliers to remove retaining ring (16) from plunger shaft (17).



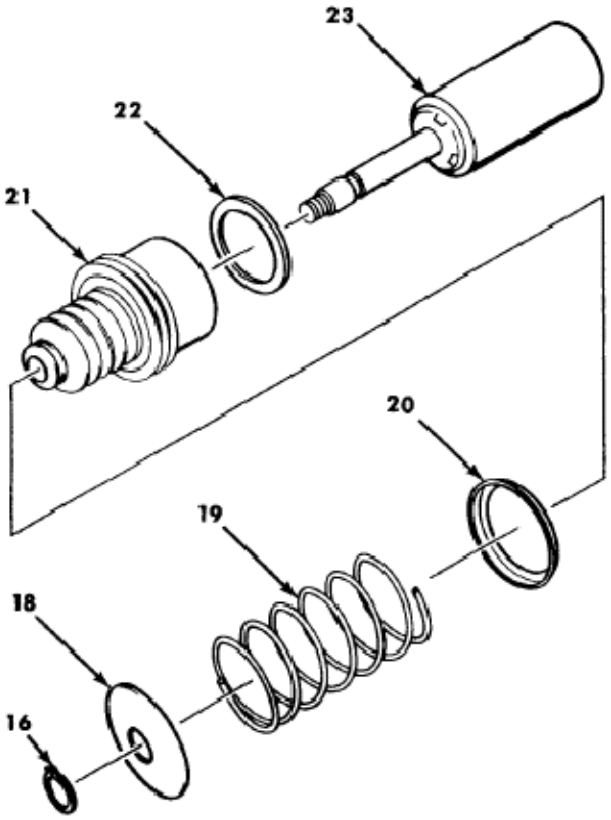
DISASSEMBLY OF THE STARTER ASSEMBLY - CONTINUED 0008 00

n. Remove outer recessed washer (18), spring (19), inner recessed washer (20), bellows (21), and washer (22) from plunger (23).

o. Inspect solenoid plunger compression spring for cracked or broken condition. Replace if defective. Replace spring if dimensions do not conform to a free length of 2.586 inch and solid length of0.668 inch. Spring load at 1.56 inches compressed length must be 12.45 to 15.56 lb.

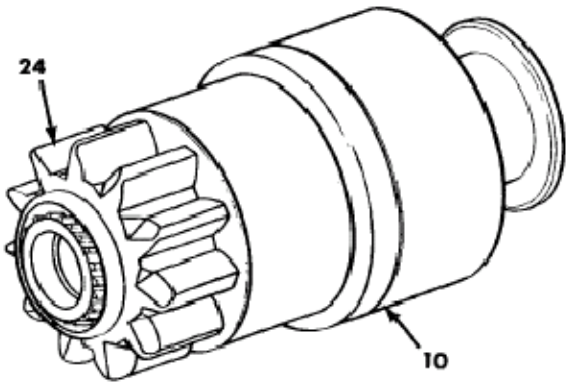
p. Inspect clutch shell for cracks. Replace if defective.

q. Inspect drive pinion for broken or worn teeth, nicks, and burs. Replace assembly if pinion is defective.



r. Hold drive pinion (24) and manually rotate clutch (10) in each direction. Rotation in a clockwise direction should be smooth and rolls lockup as rotation is reversed should be positive. Replace assembly if clutch is defective.

s. Inspect all drive splines in clutch and on sleeve for burs, and a cracked, chipped, or broken condition. Replace assembly if splines are defective.



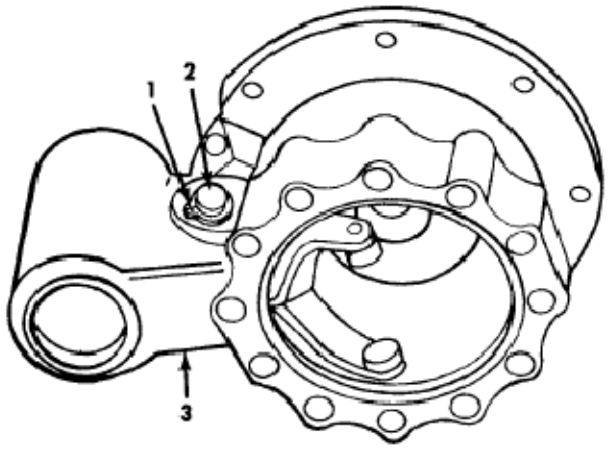
DISASSEMBLY OF THE STARTER ASSEMBLY - CONTINUED 0008 00

6. Disassembly Lever Housing Assembly.

   a. Using retaining ring pliers, remove retaining ring (1) from end of lever shaft (2).

   b. Push on end of lever shaft (2) to start shaft removal from housing (3).

   c. Hold large end of lever shaft (4) and pull shaft from housing (3).



   d. Remove shift lever (5) from housing (3).

   e. Inspect shift lever for cracks or distortion. Replace if defective.

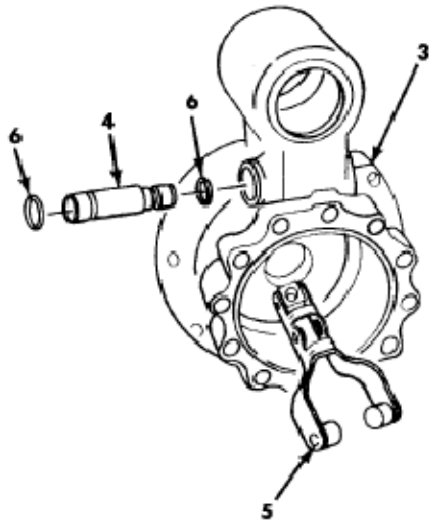
   f. Check shaft bore in shift lever. Replace lever if bore does not conform to 0.508 to 0.512 inch.

   g. Inspect shift lever clutch contact surfaces for rough spots, scratches, and nicks. Replace if defective.

   h. Remove two preformed packings (6) from lever shaft (4). Discard packings.

   i. Inspect lever shaft for rough spots, scratches, and nicks. Replace if defective.

   j. Check diameter of shaft. Replace shaft if it does not conform to 0.4980 to 0.5000 inch. The fit of the shaft in shift lever shall be 0.008 to 0.014 inch loose fit.



DISASSEMBLY OF THE STARTER ASSEMBLY - CONTINUED 0008 00

k. Drill a 5/32 inch hole near the center of exposed surface of oil reservoir cap (7) and thread a thread forming tapping screw (8) into this hole to use as a puller. Remove cap and wick (9) and discard.

l. Inspect sleeve bearing for rough spots, score marks, scratches, and nicks. Replace if defective.

NOTE

Do not remove sleeve bearing to check outside diameter and housing bore diameter unless bearing is loose in housing exceeding the 0.0040 to 0.0060 inch interference fit limits.

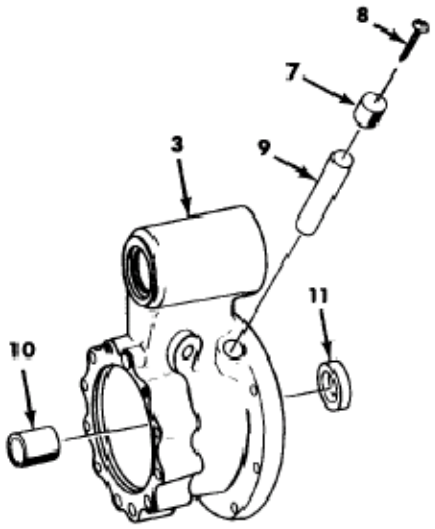
m. The wear limits for lever housing sleeve bearing inside diameter should not exceed 0.8335 to 0.8365 inch and outside diameter should not exceed 0.962 to 0.963 inch. Use a suitable puller from the bearing puller set to remove sleeve bearing (10) from lever housing (3). Discard bearing.

n. Using a suitable puller from bearing puller set, remove oil seal (11) from lever housing (3). Discard oil seal.

o. Inspect lever housing for cracks or warp age. Check for scratches, burs, and nicks on machined surfaces. Replace if defective.

p. Check bearing, lever shaft, and oil seal bores in housing. Replace housing if lever shaft bore exceeds 0.9570 to 0.9580 inch, lever shaft bore exceeds 0.508 to 0.512 inch, and oil seal bore exceeds 1.3740 to 1.3760 inch.

q. Inspect threads in tapped holes in lever housing. Replace housing if threads are stripped.



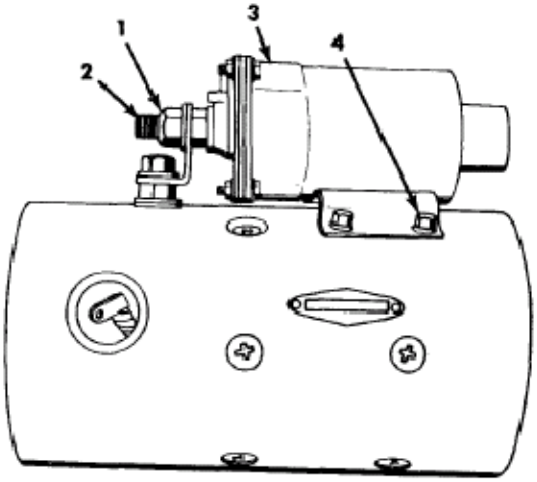
DISASSEMBLY OF THE STARTER ASSEMBLY - CONTINUED 0008 00

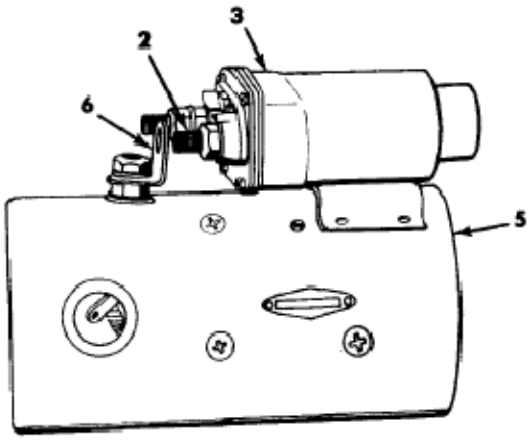
7. Disassembly Solenoid Assembly.

   a. Remove washer nut (1) from MTR terminal stud (2) on solenoid assembly (3).

   b. Remove four washer screws (4).

   c. Slide solenoid assembly (3) along starter frame (5) and away from connector (6) until terminal stud (2) is out of hole in connector (6).





   d. Remove four washer nuts (7) and screws (8).

   e. Pull terminal plate assembly (9) away from case and coil assembly (10) just enough for access to three screws (11), which connect coil leads to terminals. Early model solenoid has one screw.

   f. Remove three screws (11) and terminal plate assembly (9).

   g. Remove gasket (12) from case and coil assembly (10). Discard gasket.

   h. Remove spring (13) and contact assembly (14).

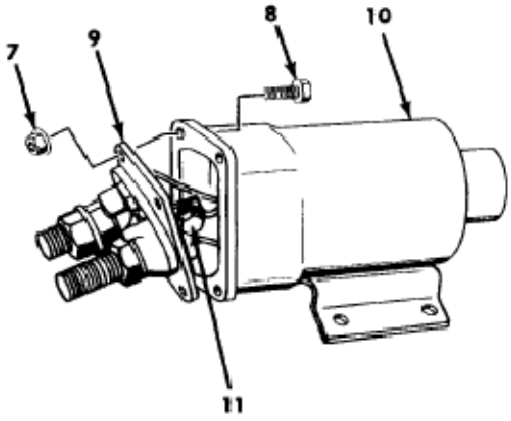
   i. Remove nylon bushing (15).

   j. Inspect windings for shorts or grounds with a pair of test probes. Replace if defective.

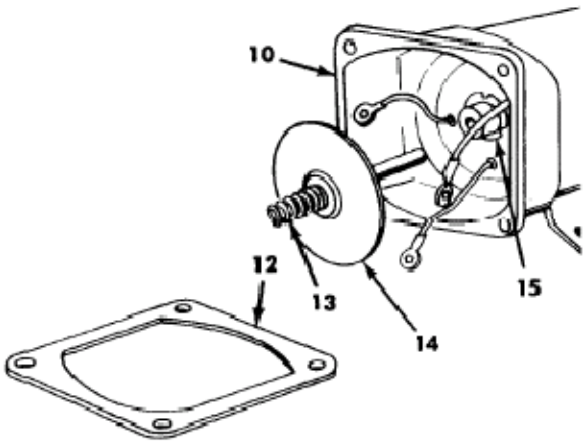
   k. Inspect case and coil assembly for cracked or broken condition. If defective, replace solenoid assembly.

   l. Inspect contacts on terminal studs for burning or pitting. Replace studs if contacts are defective.

   m. Inspect contact assembly for cracks, warp age, or pitting. Replace if defective.

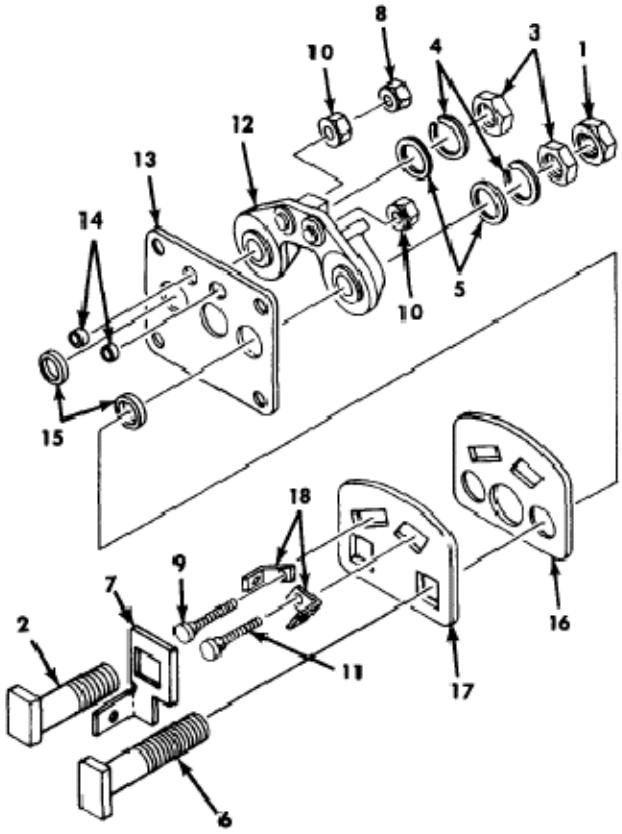


(LATE MODEL SHOWN)



DISASSEMBLY OF THE STARTER ASSEMBLY - CONTINUED 0008 00

8. Disassembly Terminal Plate Assembly.
   a. Remove extended washer nut (1) from BAT terminal (6).
   b. Remove two nuts (3) and lock washers (4). Discard lock washers.
   c. Remove two flat washers (5).
   d. Remove MTR terminal stud (2), terminal lug (7), and BAT terminal (6).
   e. Remove washer nut (8) from solenoid S terminal (9), washer nuts (10) from solenoid G terminal (11), and insulator (12).
   f. Remove terminal plate (13), bushings (14 and 15), terminal insulators (16 and 17) from terminals (18) and threaded terminals (9 and 11).



DISASSEMBLY OF THE STARTER ASSEMBLY - CONTINUED 0008 00

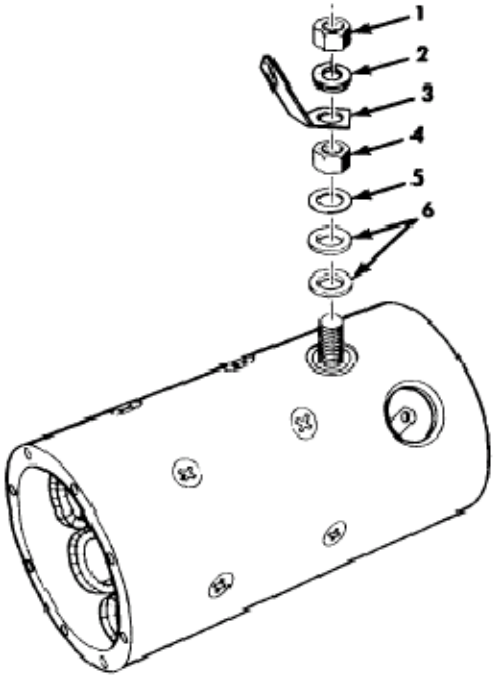
9. Disassembly Frame Assembly.

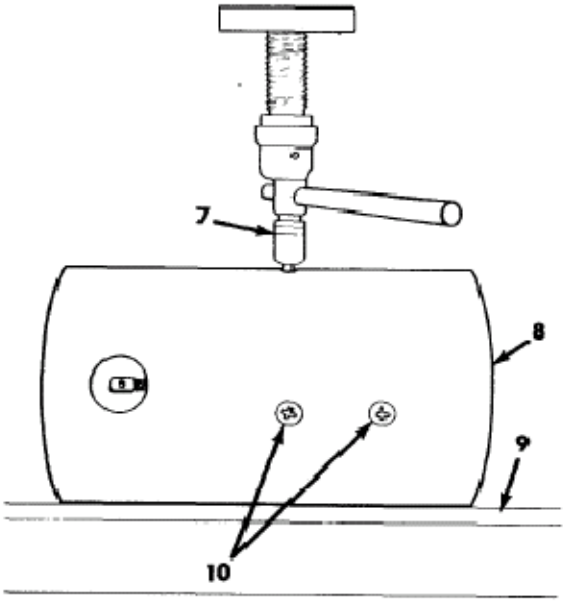
   a. Remove washer nut (1), lock washer (2), and bracket (3). Discard lock washer.

   b. Remove nut (4), flat washer (5), and two flat washers (6).

   c. Inspect pole shoes for an even, highly burnished, dark-copper color. If contact surface is rough, pitted, scored, burned, or coated with hard carbon or oil, replace pole shoes.

   d. Remove pole shoes using a screwdriver bit in a socket wrench (7) with starter frame (8) positioned in a press (9). The press will provide pressure on the wrench to prevent screwdriver bit from slipping out of pole shoe screws (10) as torque is applied.





DISASSEMBLY OF THE STARTER ASSEMBLY - CONTINUED 0008 00

e. Remove attaching pair of pole shoe screws (10) while supporting pole shoe (11) inside frame (8).

f. Using care so that field windings (12) are not damaged, remove six pole shoes (11) from inside frame (8).

g. Press insulator support (13) inward until support is clear of mounting hole in the frame (8). Remove winding (12) from inside the frame.

h. Remove insulator support (13) and washer (14) from winding stud (15).

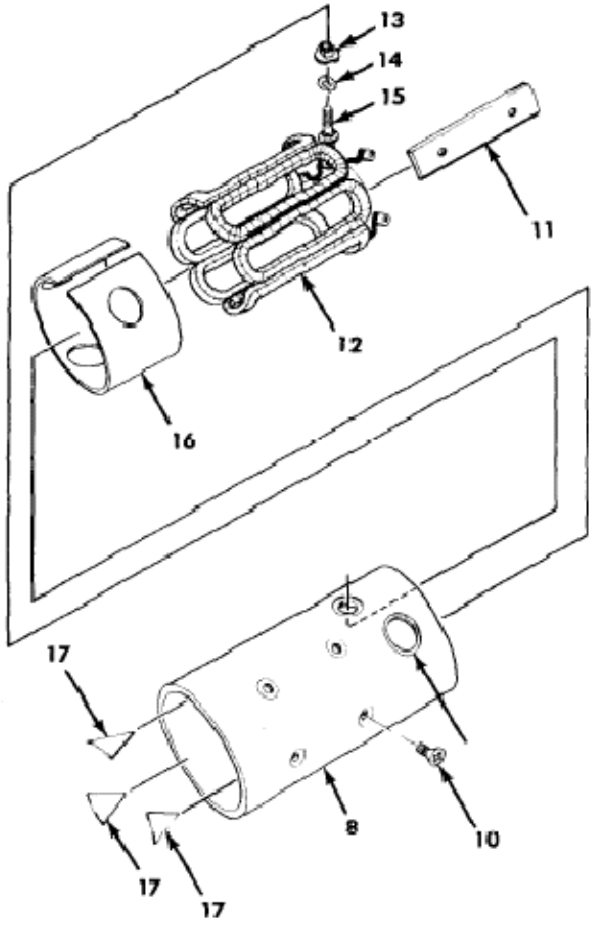
i. Remove insulator (16) and three insulator plates (17).

j. Inspect frame assembly for cracks and distortion. Replace if defective.

k. Inspect tapped holes in frame. Replace frame assembly if threads are stripped.

l. Check field windings for insulation breakdown with ohmmeter. Attach one probe of ohmmeter to the frame and the other probe to one of the field winding terminals. The resistance should not be less than one meg-ohm. Replace field winding assembly if resistance is less.

m. Inspect the terminal screw for damaged threads. Replace if threads are stripped.



END OF WORK PACKAGE

REPAIR OF COMPONENT PARTS 0009 00

THIS WORK PACKAGE COVERS:
Repair

INITIAL SETUP:

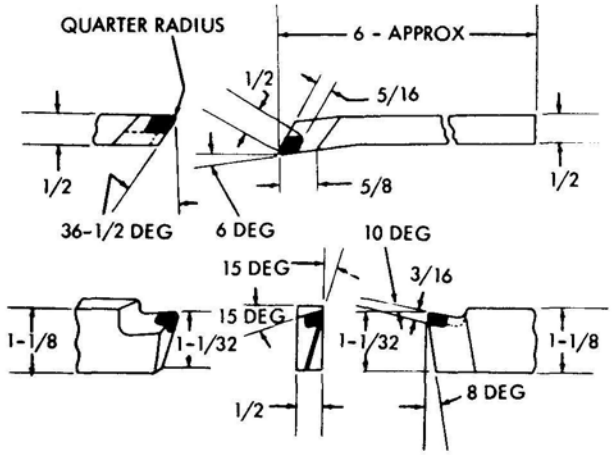
Tools and Special Tools
General mechanic's tool kit (item 1, WP 0017 00)
Hacksaw blade (item 3, WP 0017 00)
Undercutting machine (item 21, WP 0017 00)
Tap and die set (item 22, WP 0017 00)
Stone (item 23, WP 0017 00)

Materials/Parts
Sandpaper (item 5, WP 0016 00)
Goggles (item 13, WP 0016 00)
Rubber gloves (item 14, WP 0016 00)

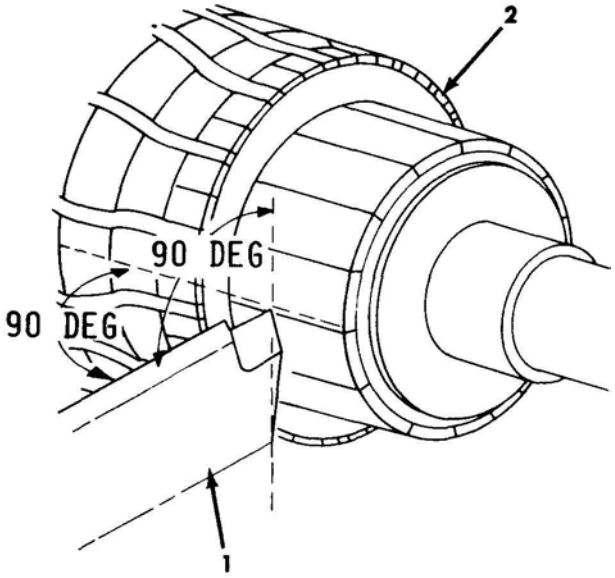
Equipment Conditions
Starter components on workbench

Equipment
Lathe, machinist

1. Repair of Commutator End Plate Assembly Lever Housing Assembly And Drive End Housing Assembly.
   a. Smooth minor scratches, burs, and dents on machined surfaces of end plate using a fine mill hand file.
   b. Repair damaged threads in end plate by chasing with correct size tap.
2. Repair of Armature Commutator
   a. Sharpen lathe cutting tool (1) to the dimensions shown. The tool must be extremely sharp. After grinding, hone the tool with a fine hard stone to ensure a smooth cut during the turning operations.
   b. Install armature (2) in lathe and position sharpened cutting tool (1) as shown. Point of cutting tool should be 1/32 inch below centerline of armature shaft.



NOTE: ALL DIMENSIONS SHOWN ARE IN INCHES



REPAIR OF COMPONENT PARTS - CONTINUED 0009 00

c. Set lathe to turn armature (2) at 800 rpm.

d. Make only light cuts, no more than 0.005 inch on each pass, until entire surface of all commutator bars (3) is involved.

e. Make one final cut at no more than 0.002 inch deep.

f. Check diameter of commutator (3). The commutator diameter on armature should be between 2.3080 to 2.3180. If less than minimum turned diameter of 2.1930 inch, armature (2) must be replaced.

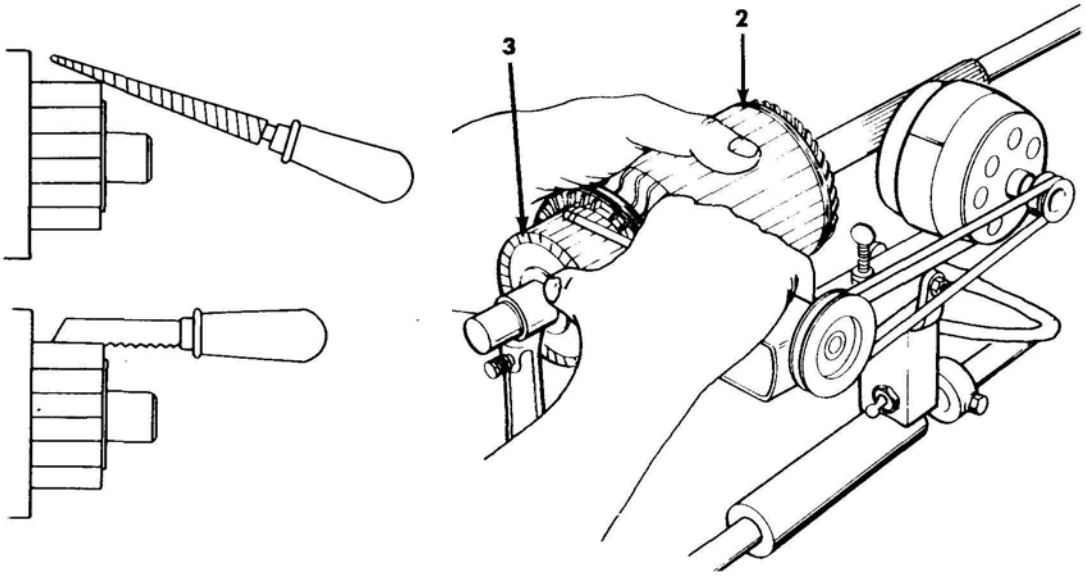
CAUTION

Use care when undercutting so that no metal is removed from sides of segments and no mica is left standing against side of a segment.

g. If turned diameter of commutator (3) is no less than minimum limit, undercut mica to a depth of 0.025 to 0.032 inch below commutator surface.

h. Start groove in mica with a 3-cornered file.

i. Undercut mica with a hacksaw blade.



REPAIR OF COMPONENT PARTS - CONTINUED 0009 00

j. Mica (4) must be cut away clean between segments (5).

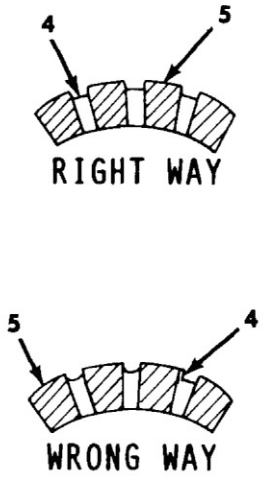
k. Mica (4) must not be left with a thin edge next to segments (5).

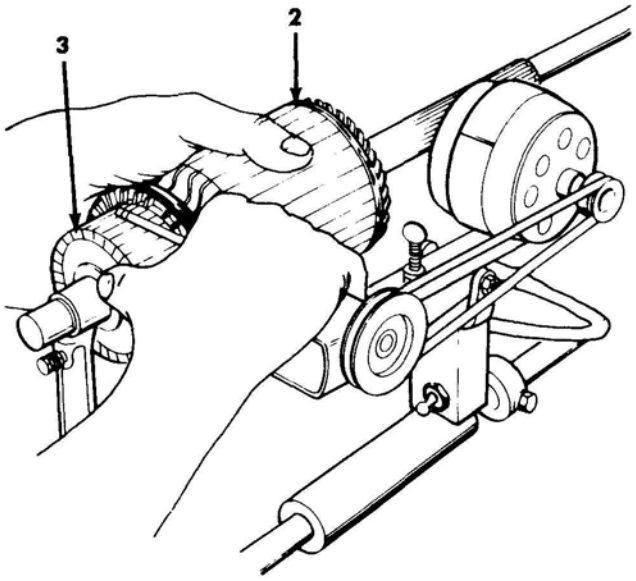
WARNING

Compressed air used for cleaning purposes will not exceed 30 psi. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

l. After undercutting, remove all copper and mica particles with compressed air.

m. Put armature (2) back in lathe and set for 1500 rpm. Use no. 2/0 sandpaper to polish commutator (3) while armature is rotating.





END OF WORK PACKAGE

ASSEMBLY OF THE STARTER 0010 00

THIS WORK PACKAGE COVERS:
Assembly and Adjustment

INITIAL SETUP:

Tools and Special Tools
General mechanic's tool kit (item 1, WP 0017 00)
Brush spring lifter (item 4, WP 0017 00)
Retaining ring pliers (item 7, WP 0017 00)
Spring wind tool (item 24, WP 0017 00)

Materials/Parts
Oil, lubricating (item 2, WP 0016 00)
Tape, adhesive (item 4, WP 0016 00)
Sandpaper (item 5, WP 0016 00)
Sealing compound (item 6, WP 0016 00)

Materials/Parts
Varnish (item 7, WP 0016 00)
Grease (item 8, WP 0016 00)
Wood block (item 9, Appendix C)
Measuring tape (item 16, WP 0016 00)
Starter repair kits
Lockwashers
Gaskets

Equipment Conditions
Starter components on workbench; cleaned, inspected, and repaired as necessary

NOTE

When inspection indicated that a component subassembly was serviceable, disassembly was not necessary. Skip procedure for parts that were not disassembled.

ASSEMBLY OF THE STARTER - CONTINUED 0010 00

Assembly

1. Frame Assembly.

   a. Install insulator washer (1) and insulator support (2) on terminal stud (3) of winding (4).

   b. Position winding (4) in frame (5) and bring end of terminal stud (3) out through hole in frame (5) to seat support (2).

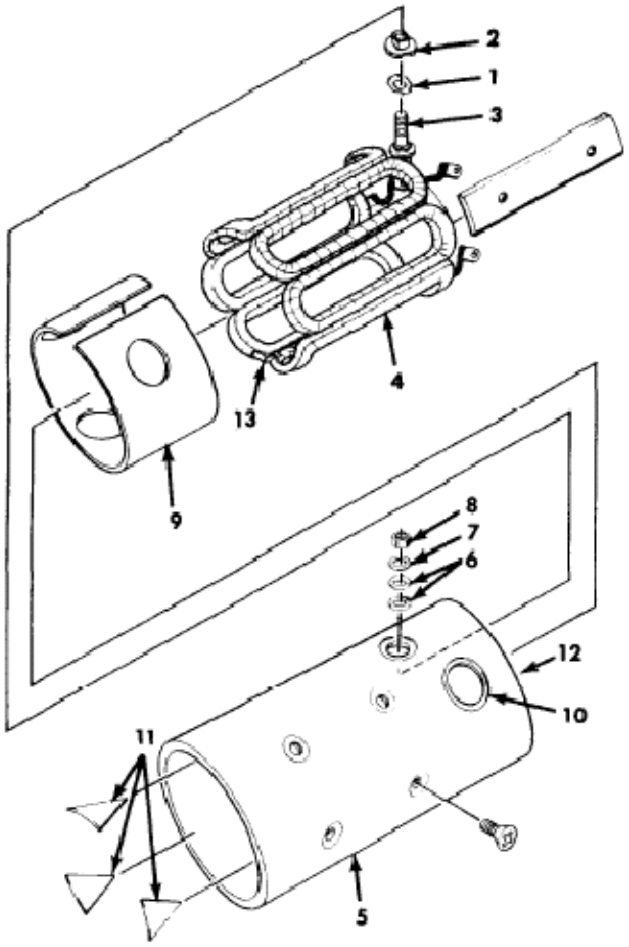
CAUTION

When torque is applied, observe stud to keep from twisting.

   c. Install two insulating washers (6), one metal washer (7), and hex nut (8). Torque to 20–25 lb–ft (27 to 34 N•m).

   d. Install nylon sheet insulator (9) at commutator end of frame (5) so that its three large holes are aligned at inspection holes (10) in frame (5).

   e. Install three triangular insulator plates (11) at drive end of the frame. One side of each insulator must be parallel to drive end surface of frame and point of insulator toward commutator end (12) of frame. Each of these insulators will be positioned between the frame and one of the coil pair welded connections (13).



ASSEMBLY OF THE STARTER - CONTINUED 0010 00

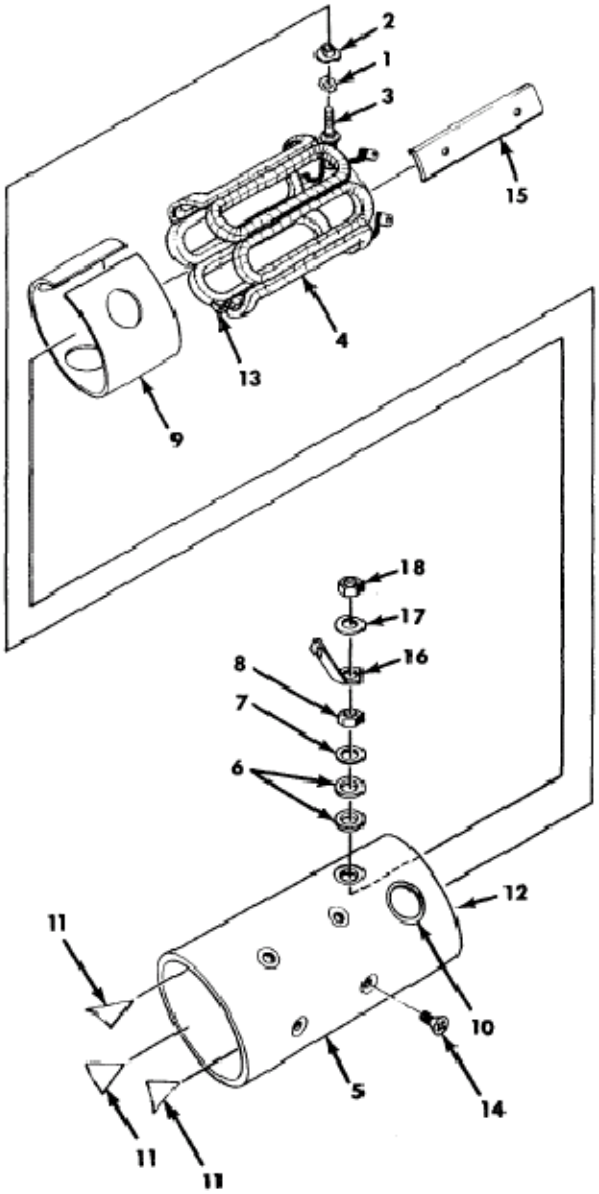
f. Coat threads of pole shoe screws (14) with sealing compound, and use two of these screws to attach each of six pole shoes (15) inside the frame (5). Torque pole shoe screws to 15–25 lb–ft (20.3 to 34.5 N•m).

CAUTION

Do not overcoat pole shoe faces with varnish. Coating faces could cause armature rub.

g. Coat inside of frame (5) with varnish. Cover field windings (4), pole shoes (15) and insulator plates (11), but leave 0.4 inch of inner frame surface without varnish around each end of frame.

h. Install bracket (16), new lock washer (17), and nut (18) but do not tighten until the solenoid assembly is installed.



ASSEMBLY OF THE STARTER - CONTINUED 0010 00

2. Terminal Plate Assembly.

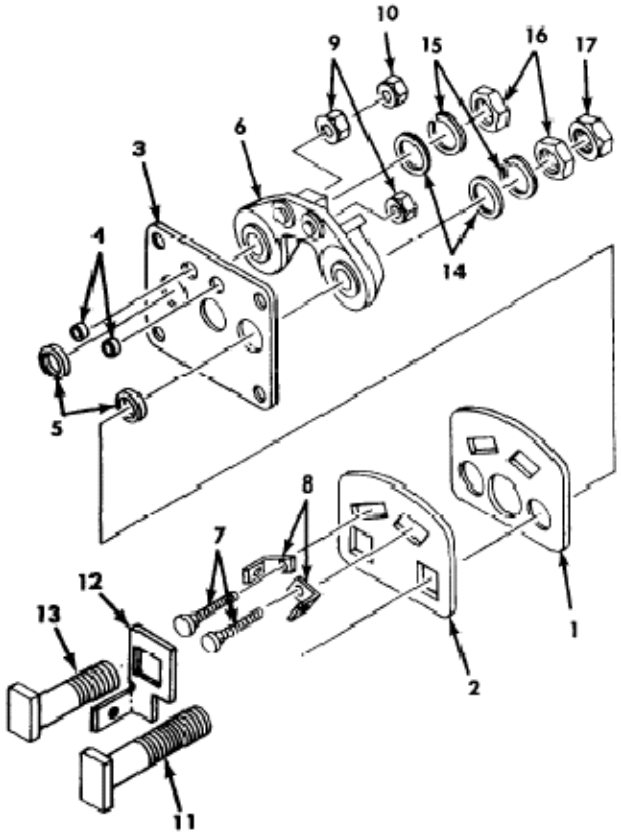
   a. Align terminal insulators (1 and 2) and terminal plate (3) with bushings (4 and 5) in place on insulator (6). Install threaded terminals (7) through terminals (8) and through aligned parts. Secure parts together with washer nuts (9). Torque to 12–15 lb–in (1.4 to 1.7 N•m).

   b. Install washer nut (10). Torque to 12–15 lb–in (1.4 to 1.7 N•m).

   c. Align BAT terminal stud (11) in terminal lug (12) and align MTR terminal (13) so that longer dimensions on heads are parallel as threaded ends are installed through previously assembled parts.

   d. Secure terminals (11 and 13) with flat washers (14), new lock washers (15), and nuts (16). Torque to 15–25 lb–ft (20 to 34 N•m).

   e. Install washer nut (17). Tighten finger tight.



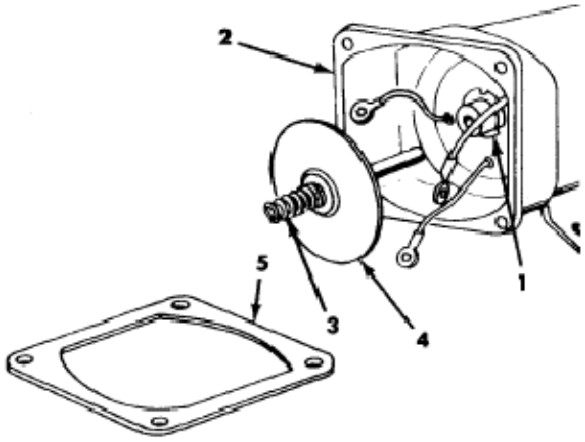
ASSEMBLY OF THE STARTER - CONTINUED 0010 00

3. Solenoid Assembly.
   a. Install nylon bushing (1) in core of case and coil assembly (2).
   b. Put spring (3) on contact assembly (4) and install into the case and coil assembly (2).

CAUTION

Do not lubricate gasket used between case and terminal plate.

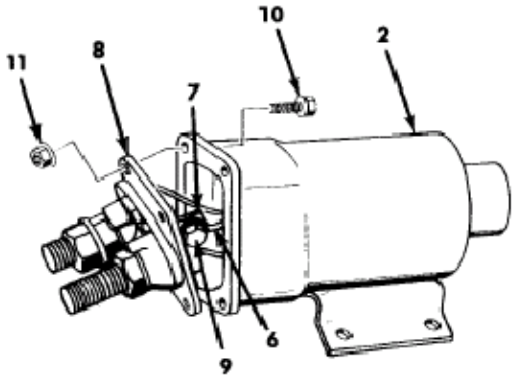
   c. Position new gasket (5) on case and coil assembly (2).



NOTE

There are two solenoid assemblies 1119872 (early) and 1115563 (late).

   d. Attach leads (6) of solenoid coils to terminals (7) on terminal plate assembly (8) with three screws (9). Early model has one screw. Torque to 12-15 lb-in (1.4 to 1.7 N•m).
   e. Attach terminal plate assembly (8) to case and coil assembly (2) with four screws (10) and four washer nuts (11). Torque to 16-30 lb-in (1.8 to 3.4 N•m).



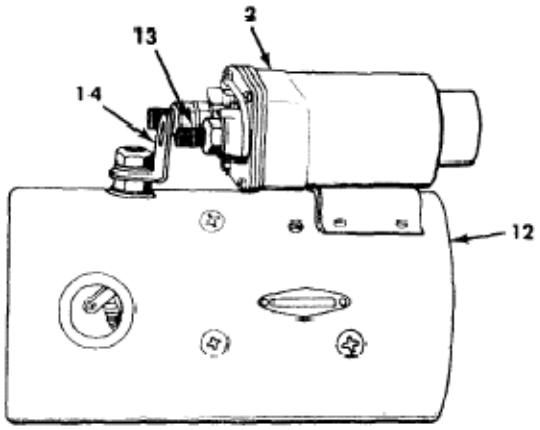
(LATE MODEL SHOWN)

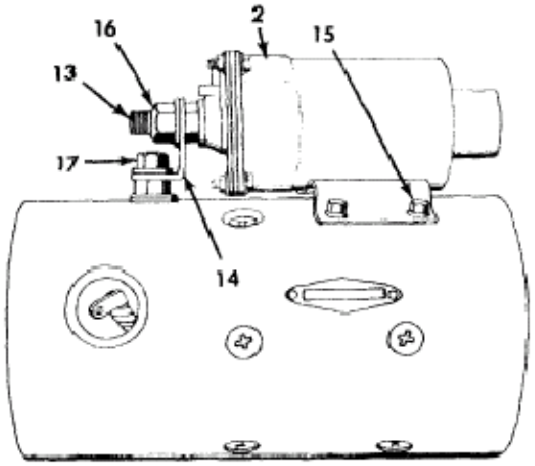
ASSEMBLY OF THE STARTER - CONTINUED 0010 00

f. Position solenoid assembly (2) on frame assembly (12) so that MTR terminal stud (13) engages hole in bracket (14).

g. Apply sealing compound to threads of four bolts (15) and install to attach solenoid assembly (2) to starter frame assembly (12). Torque bolts to 95–125 lb–in (10.7 to 14.1 N•m).

h. Install washer nut (16) on MTR terminal stud (13) of solenoid assembly (2) to secure bracket (14) to terminal. Torque washer nut (16) and washer nut (17), which secures other end of the bracket to field coil terminal to 20–25 lb–ft (27 to 34 N•m).





4. Brush Holder Assembly.

a. Install a new brush spring (1) in brush holder (2), using brush spring wind tool (3) as follows:

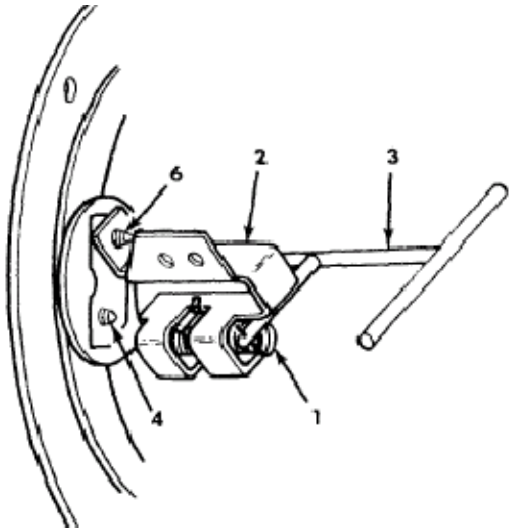
1) Back out brush holder attaching screw (4) which is in line with spring (I) and loosen pivot screw (6).

2) Pivot brush holder (2) inward about 30 degrees for tool clearance and tighten pivot screw (6) to hold in position.

3) Put spring (1) in spring wind tool (3) and hook center of spring in holder (2).

4) Rotate lifter clockwise to wind spring (1) and push spring up into holder (2).

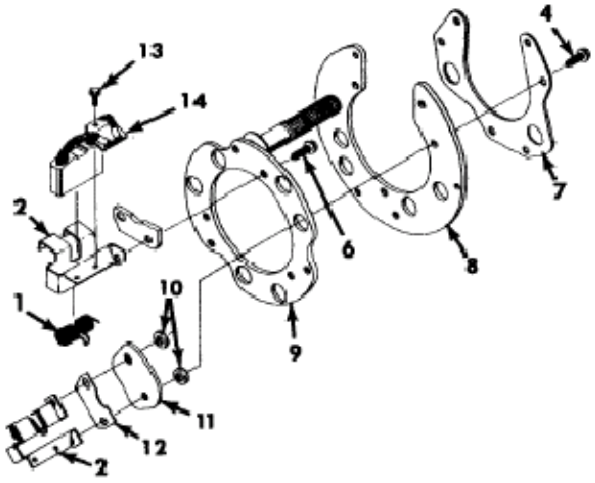
5) Pivot holder (2) back into normal position and torque attaching screws (4) with 18–24 lb–in (2.0 to 2.7 N•m).



ASSEMBLY OF THE STARTER - CONTINUED 0010 00

b. Align conductor (7) and brush plate insulator (8) with terminal and plate assembly (9).

c. Install six insulated brush holder washer screws (4), six insulator washers (10), three insulators (11), three plates (12), and three brush holders (2) with springs (1). Install six hex head screws (13) to attach brush leads (14) to holders (2). Torque screws (4), (6), and (13) to 18-24 lb-in (2.0 to 2.7 N•m).



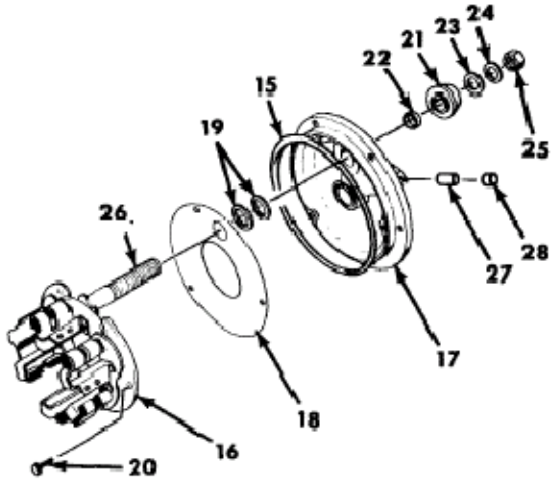
d. Apply a light coat of grease to preformed packing (15). Install assembled brush holder assembly (16) on commutator end plate (17) with insulator (18), two washers (19), and new preformed packing (15) in position and secure using three screws (20). Torque to 18-24 lb-in (2.0 to 2.7 N•m).

e. Install terminal stud insulator (21), insulating bushing (22), flat washers (23), new lock washer (24), and plain hexagon nut (25) on terminal stud (26). Torque to 20-25 lb-ft (27 to 34 N•m).

NOTE

Check insulator (21) after torque for cracks.

f. Install new lubricated wick (27) and oil reservoir cap (28) into end plate (17). Tap in cap flush to plate using wood block and hammer.



ASSEMBLY OF THE STARTER - CONTINUED 0010 00

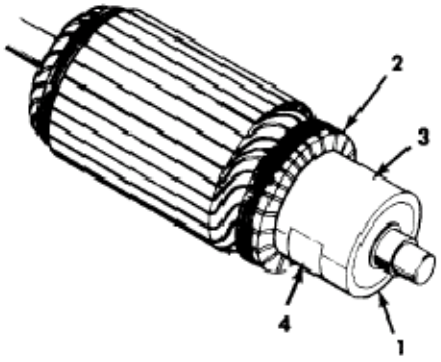
5. Seating Used Brushes Assembly.

NOTE

New brushes will not require seating. Seating procedure applies to brushes which have been run in some other location.

a. Seat any used brushes installed as follows:

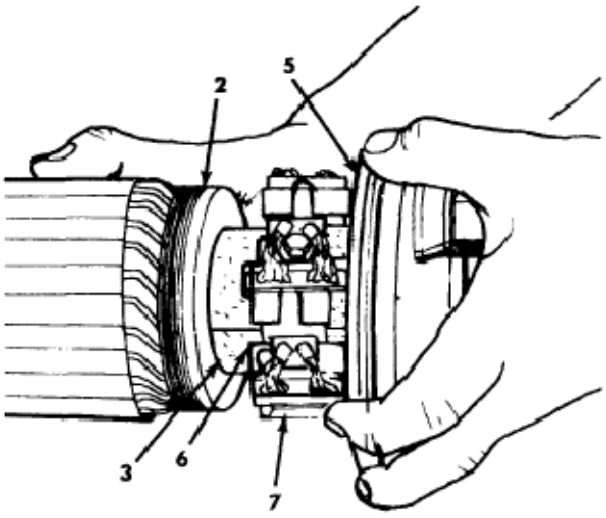
1) Wrap commutator (1) on armature (2) with no. 2/0 sandpaper strip (3), sand side out, and secure with adhesive tape (4).

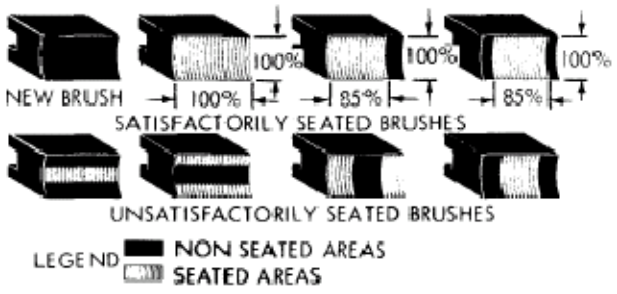


2) Temporarily install armature (2) in commutator end plate assembly (5) so that brush ends (6) are riding on sandpaper (3).

3) Manually rotate armature (2) clockwise until the contact surface of each brush (6) has been seated 85 to 100 percent in accordance with illustration.

b. Remove sandpaper (3) and thoroughly clean armature (2) and brush holder assembly (7) to remove all residue from the seating operation.



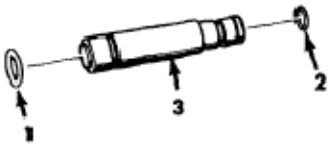


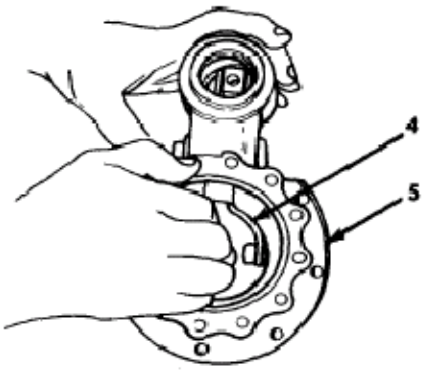
ASSEMBLY OF THE STARTER - CONTINUED 0010 00

6. Plunger and Lever Housing Assembly.

   a. Apply a light coat of grease to new preformed packings (1 and 2) and install at respective ends of lever shaft (3).

   b. Position shift lever (4), channel side inward, in lever housing (5) and install lever shaft (3), small end first, through holes in lever and housing.

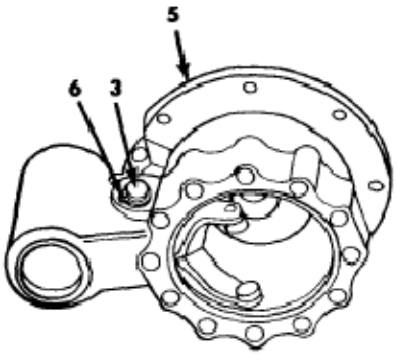


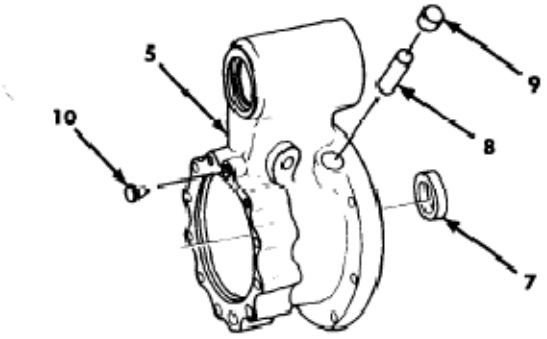


   c. Install retaining ring (6) to secure lever shaft (3) in housing (5).

   d. Install oil seal (7) at inner end of armature bore in lever housing (5).

   e. Install new lubricated wick (8) and oil reservoir cap (9) into lever housing (5). Tap in flush to housing using a wood block and hammer. Install red rubber plug (10) into lever housing.





ASSEMBLY OF THE STARTER - CONTINUED 0010 00

f. Install flat washer (11) in bellows (12).

g. Install bellows (12) with washer on plunger shaft (13).

h. Install recessed washer (14) and spring (15) over bellows (12).

i. Compress spring (15) and install recessed washer (16). Using retaining ring pliers install retaining ring (6) at groove in plunger shaft (13).

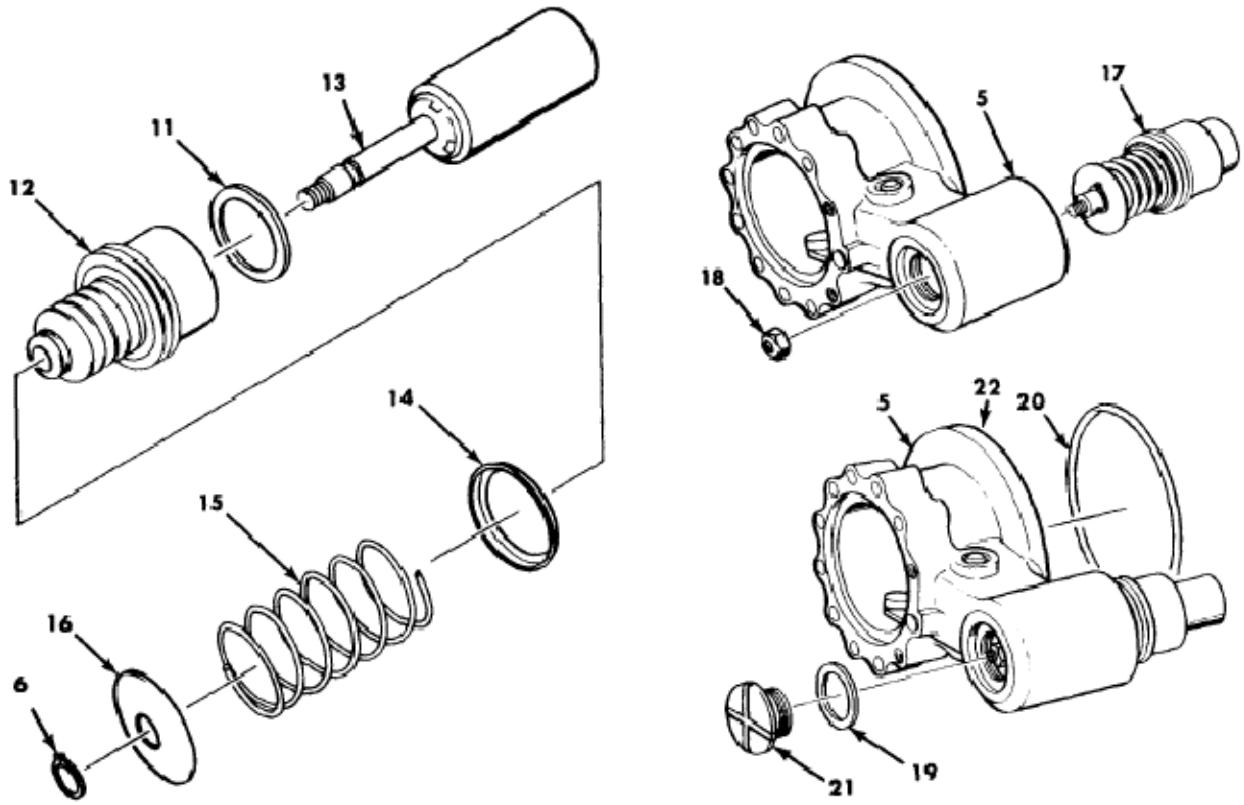
j. Put assembled plunger (17) into lever housing assembly (5) with end through coupling hole of the lever.

k. Install self-locking nut (18), but do not bottom on plunger threads. Position of nut will be adjusted later for pinion clearance.

l. Apply a light coat of grease to gasket (19) and preformed packing (20). Install inspection plug (21) and new gasket (19). Do not tighten plug at this time.

m. Install new preformed packing (20) in groove at mounting face (22) of the housing (5).

n. Apply a light coat of sealing compound to mounting face of lever housing (5).



ASSEMBLY OF THE STARTER - CONTINUED 0010 00

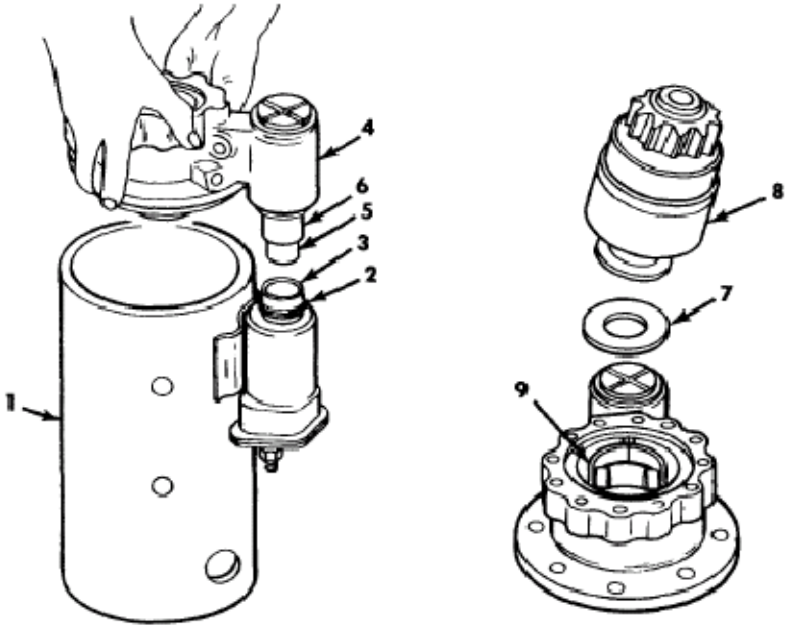
7. Lever Housing and Drive Clutch Assembly.

   a. Set frame assembly (1) on end and put hose clamp (2) over plunger socket of solenoid assembly (3).

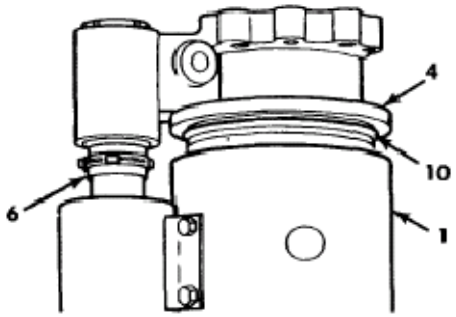
   b. Bring lever housing assembly (4) into position over the frame (1), start plunger (5) into solenoid assembly (3). Ensure that end of bellows (6) is not crimped as it slides over plunger socket when housing and frame are brought closer together.

   c. Soak brake washer (7) in oil prior to installation into lever housing (4).

   d. Apply a light coat of grease to internal spline on drive clutch assembly (8). Tilt drive clutch assembly (8) as necessary to engage with forked end of shift lever (9).



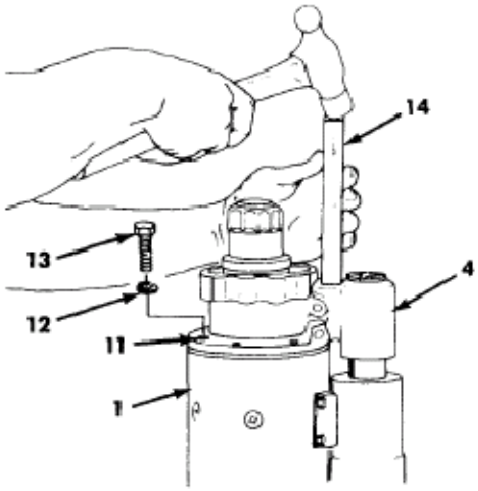
   e. Again check that bellows (6) is not crimped and ensure that new preformed packing (10) is in its groove as lever housing (4) enters frame (1).



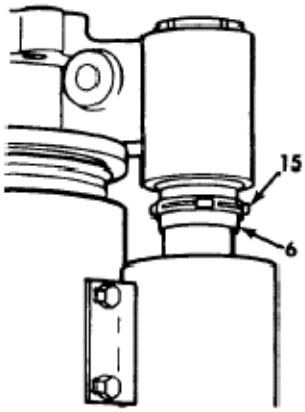
ASSEMBLY OF THE STARTER - CONTINUED 0010 00

f. Secure at seven places (11) with new lock washers (12) and screws (13). Use a wood block (14) and hammer to seat lever housing (4) in frame (1).

g. Torque screws (13) to 144-192 lb-in (16.3 to 21.7 N•m).



h. Put hose clamp (15) over end of bellows (6) and tighten securely.



ASSEMBLY OF THE STARTER - CONTINUED 0010 00

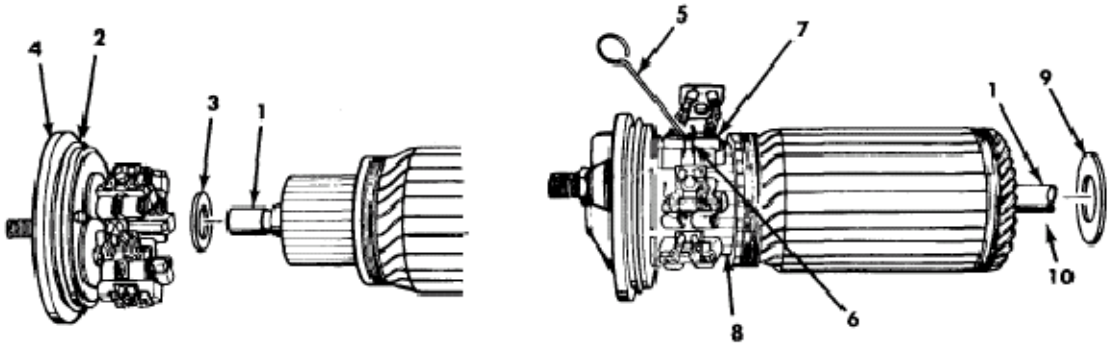
8. Commutator End Plate Assembly.

   a. Apply a light coat of grease to armature shaft (1) and on preformed packing (2). Install flat washer (3) on commutator end of armature shaft (1) and new preformed packing (2) in groove around end plate (4).

   b. Bring commutator end plate assembly (4) into position.

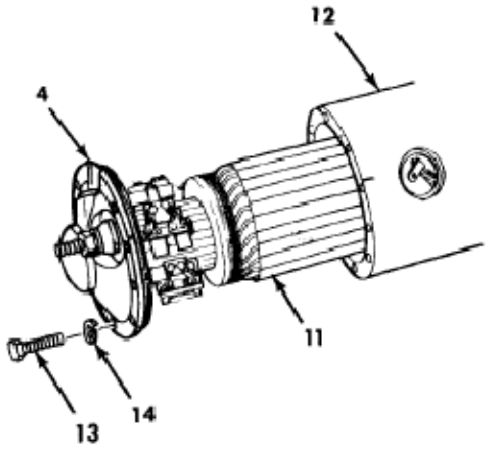
   c. Use brush spring lifter tool (5) to pull brush spring (6) and raise each brush (7) onto commutator (8). Alternate method of assembling brush holder assembly onto commutator: brush springs can be pried off brushes, brushes raised in holder, and springs released against side of brush.

   d. Apply a light coat of grease to both sides of washer (9). Install washer (9) on drive end (10) of armature shaft (1).



   e. Slide armature (11) with commutator end plate assembly (4) in place into the starter frame (12). The maximum end play of armature shall not exceed 0.0700 inch. Align scribe marks on end plate (4) and frame made during disassembly.

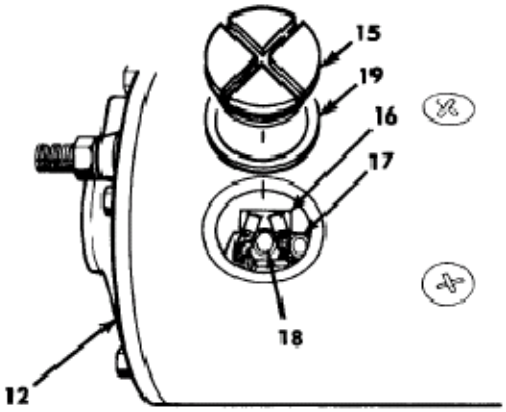
   f. Install screws (13) and new lock washers (14) at six places to secure end plate (4) to frame (12). Torque screws to 13–17 lb–ft (17.6 to 23.1 N•m).



ASSEMBLY OF THE STARTER - CONTINUED 0010 00

g. Apply sealing compound around threaded area of plugs (15). Attach each of three field coil leads (16) to its brush holder (17) using screw (18). Torque to 18–24 lb–in (2.0 to 2.7 N•m).

h. Apply a light coat of grease to gaskets (19). Install two plugs (15) and new gaskets (19) into frame assembly (12). Torque plugs to 25–30 ft–lb (N•m).

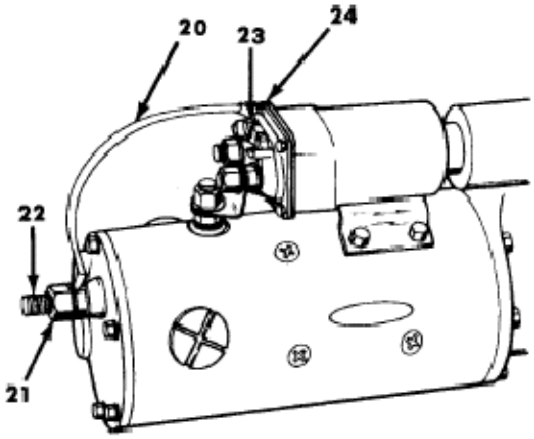


i. Install one end of electrical lead assembly (20) and washer nut (21) to secure on ground terminal stud (22). Torque nut to 20–25 lb–ft (27 to 34 N•m) of torque.

NOTE

There are two solenoid assemblies, 1119872 (early) and 1115563 (late).

j. Install other end of electrical lead assembly (20) and washer nut (23) to G terminal of solenoid assembly (24). On early model solenoid assembly, remove lower right screw and nut from terminal plate. Install other end of lead assembly and screw and nut. Torque nut to 16–30 lb–in (1.8 to 3.4 N•m).



(LATE MODEL SHOWN)

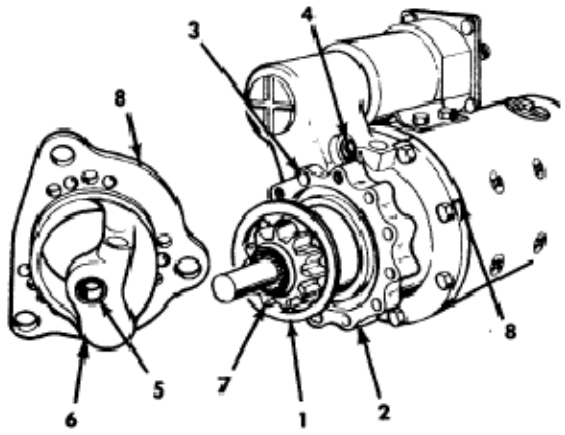
ASSEMBLY OF THE STARTER - CONTINUED 0010 00

9. Drive End Housing Assembly.

   a. Apply a light coat of grease to gasket (1). Install new gasket (1) in counterbore at outer end of lever housing (2).

   b. Install red rubber seal plug (3) into counterbored tapped hole of lever housing (2). Hole is almost in front of lever pivot (4).

   c. Apply a light coat of grease to inner surface of bushing (5) in end housing (6). Bring drive end housing (6) into position over drive clutch assembly (7) and align scribe marks (8) made during disassembly.



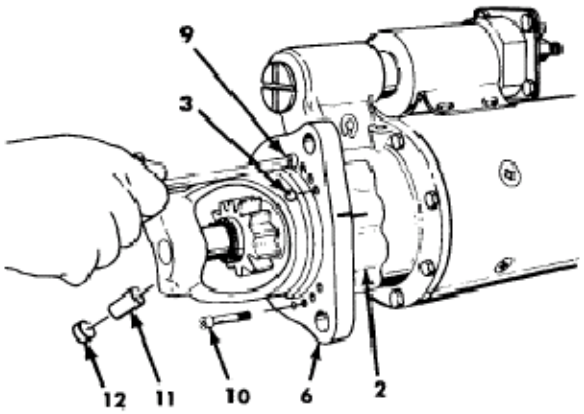
   d. Install short socket head bolt (9) through mounting flange of drive end housing (6) and into lever housing (2) at position shown.

   e. Install five long socket head bolts (10) at all other attach points for lever housing (2).

   f. Torque six socket head bolts to 13–17 lb–ft (17.6 to 23.0 N•m).

   g. Install rubber ball seal plug (3) in each of six unused holes.

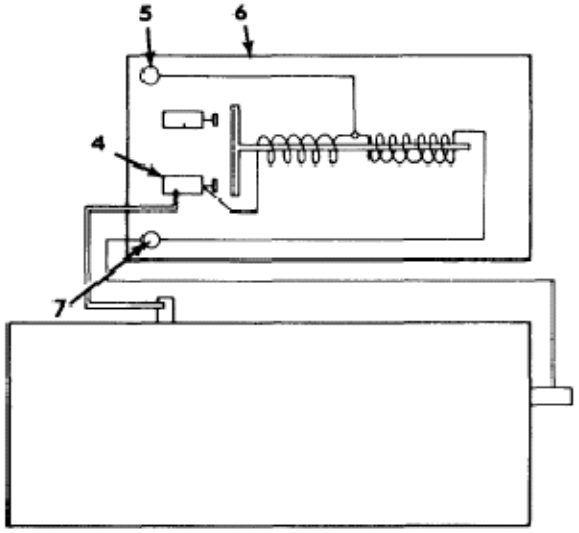
   h. Install new lubricated wick (11) and oil reservoir cap (12) into drive end housing (6). Using wood block and hammer, tap in cap flush with housing.

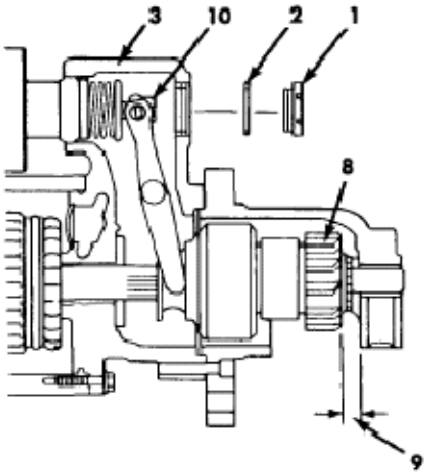


ASSEMBLY OF THE STARTER - CONTINUED 0010 00

Adjustment

1. Adjustment of Drive Pinion Clearance.
   a. Remove inspection plug (1) and gasket (2) from lever housing (3).
   b. Connect 24-volt power to MTR (4) and S (5) terminals of solenoid assembly (6).
   c. Make a momentary connection between solenoid G terminal (7) and solenoid MTR terminal (4); drive (8) will shift to engaged position and remain even though MTR connection is removed.
   d. Manually push drive pinion (8) towards opposite end of the starter to eliminate backlash from measurement.
   e. Using measuring tape, measure distance (9) of pinion face to machined surface of drive end housing as shown.
   f. Turn adjustment nut (10) as necessary to obtain clearance measurement (9) of 21/64 to 25/64 inch.
   g. Remove power supply connection and again connect electrical lead to G terminal of solenoid assembly. Torque washer nut to 16-30 lb-in (1.8 to 3.4 N•m).
   h. Apply a light coat of grease to gasket (2). Install gasket (2) and inspection plug (1) into lever housing (3). Torque to 4-6 lb-ft (5.4 to 8.1 N•m).





END OF WORK PACKAGE

OPERATIONAL TESTING OF THE STARTER 0011 00

THIS WORK PACKAGE COVERS:

Testing

INITIAL SETUP:

Equipment

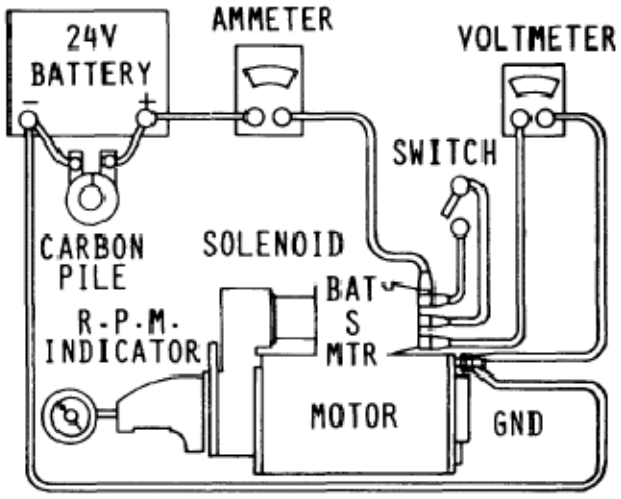
Test Stand, 500A
Or
Test bench setup consisting of:
Suitable mount of holder for starter
Carbon pile and fully charged 24V battery or equivalent power supply
Ammeter, 200A
Voltmeter, 0–50 vdc
RPM indicator, 10,000 rpm suitable interconnect

Equipment Conditions

Starter completely assembled (need not be fully sealed) and mounted on test setup

Testing

1. NO-LOAD Performance Test.
   a. Connect starter to power source as shown.
   b. Adjust carbon pile (or power supply) to provide 20 volts, as read on voltmeter, while starter is operating.
   c. Current measurement shown on ammeter shall be 95 to 120 amperes, and speed of rotation shall be 5500 to 7500 rpm.



END OF WORK PACKAGE

WATERPROOF TESTING OF THE STARTER 0012 00

THIS WORK PACKAGE COVERS:

Testing

INITIAL SETUP:

Equipment

Air compressor (6 psi)
Air test setup:
Air pressure gage – 0-10 psi
Shutoff valve
Air chamber – 1 cu ft
Leak test fitting (Fig. 3, WP 0013 00)
Water dip tank
Jib boom

Materials/Parts

Soap (item 10, WP 0016 00) and water solution
Goggles (item13, WP 0016 00)
Rubber gloves (item 14, WP 0016 00)

Equipment Conditions

Starter completely assembled, tested, and sealed

Testing

1. Starter Sealing Test Setup.
   a. Remove one brush inspection plug and gasket from starter frame.
   b. Install leak test fitting and gaskets in opened hole.
   c. Install pressure gage in chamber and shutoff valve at chamber in let.

WARNING

Compressed air used for cleaning purposes will not exceed 30 psi. Use only with effective chip guarding and personal protective equipment (goggles/ shield, gloves, etc.).

   d. Attach hose from dry compressed air supply adjusted for 6 psi to starter leak test setup.
2. Alternate 1 Test Procedure.

CAUTION

Do not wet drive end housing or drive clutch assembly.

   a. Using jib boom, lower starter into a tank of clean soap and water until only drive end housing is exposed above water surface.
   b. Visually check for air bubbles. Bubbles show location of leaks, which must be corrected.
3. Alternate 2 Test Procedure.
   a. Close air valve to trap pressure inside starter and observe pressure gage for three minutes. Pressure decrease exceeding 0.5 psi/minute indicates an unacceptable leak.
   b. Restore pressure as necessary, and apply soap and water solution to external bolts, screws, and gaskets to find location of leak. Soap bubbles will form over location of leak which must be corrected.

END OF WORK PACKAGE

ILLUSTRATED LIST OF MANUFACTURED ITEMS 0013 00

THIS WORK PACKAGE COVERS:
Scope, How to Use Index, Explanation of Illustrations

ILLUSTRATED LIST OF MANUFACTURED ITEMS

INTRODUCTION

Scope

This work package includes complete instructions for making items authorized to be manufactured.

How to Use the Index of Manufactured Items

A part number index in alphanumeric order is provided for cross-referencing the part number of the item to be manufactured to the page that covers fabrication criteria.

Explanation of the Illustrations of Manufactured Items

All instructions needed by maintenance personnel to manufacture the item are included on the illustrations. (When applicable, a reference to the associated RPSTL TM or RPSTL work package shall be entered here.) All bulk materials needed for manufacture of an item are listed by part number or specification number in a tabular list on the illustration.

PART NUMBER LIST

ITEM	REFERENCE
Brush Spring Lifter	Figure 1
Spring Wind Tool	Figure 2
Leak Test Fitting	Figure 3

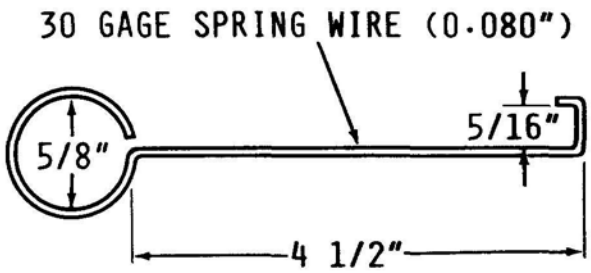


Figure 1. Brush Spring Lifter.

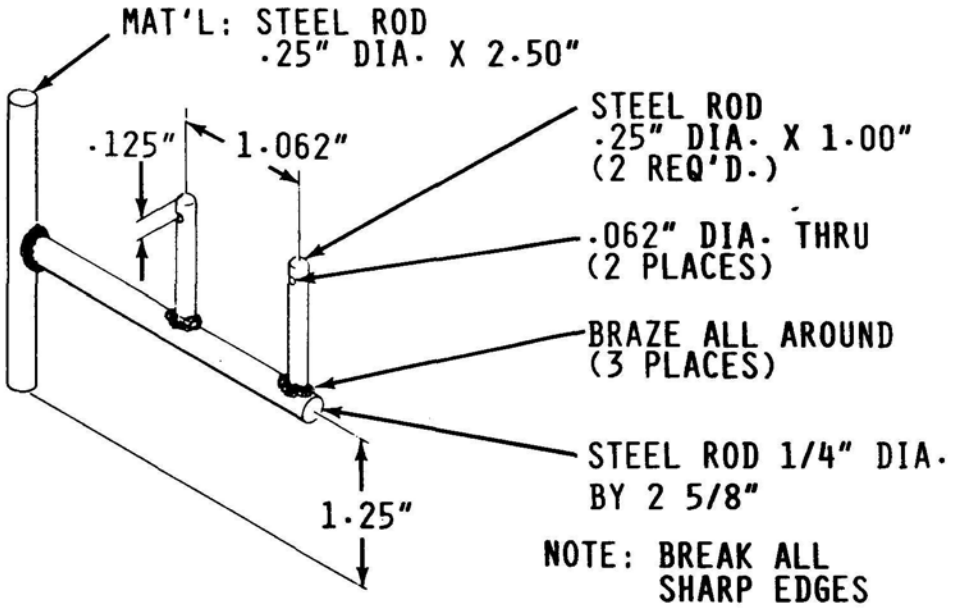


Figure 2. Spring Wind Tool.

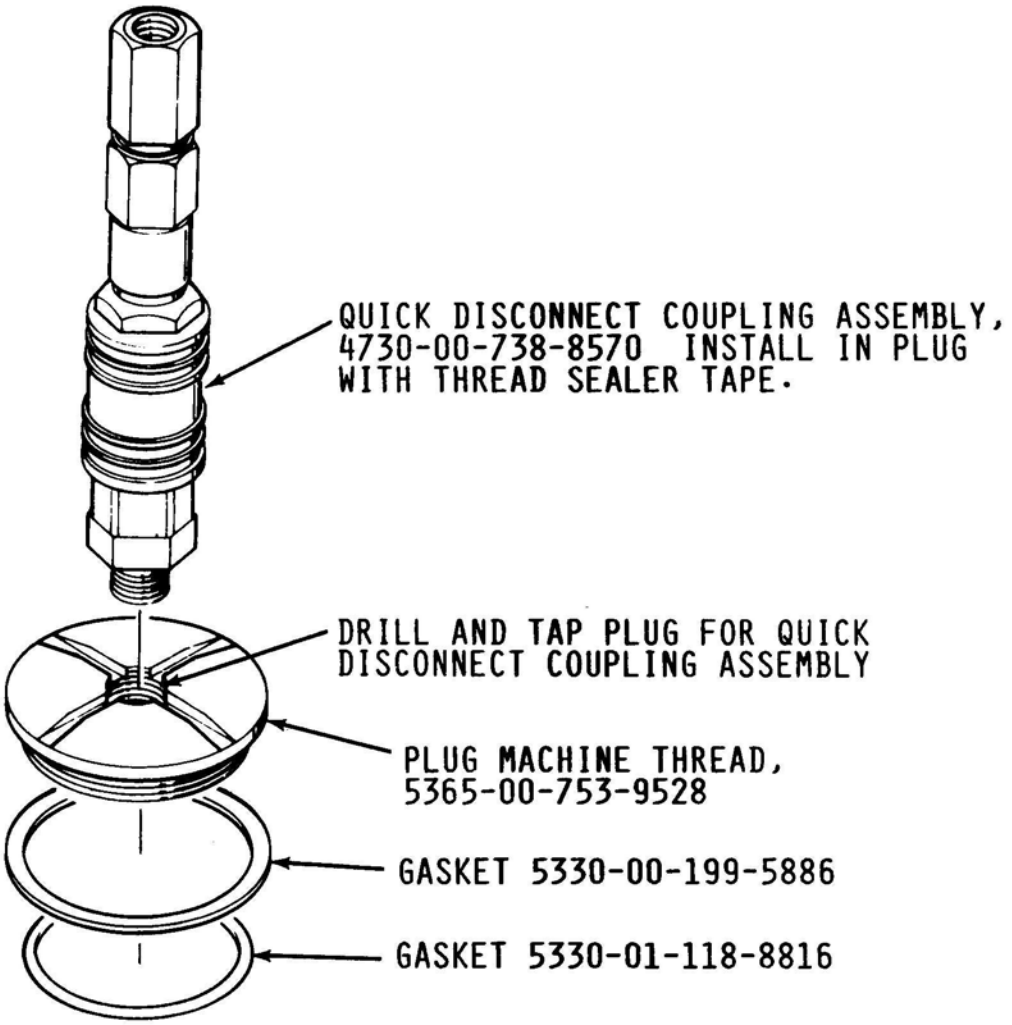


Figure 3. Leak Test Fitting.

END OF WORK PACKAGE

CHAPTER 4

SUPPORTING INFORMATION

REFERENCE WORK PACKAGE 0014 00

THIS WORK PACKAGE COVERS:

Scope, Arrangement of Listings, and Publication Indexes

SCOPE

This work package lists all field manuals, forms, technical manuals and miscellaneous publications referenced in this manual.

STANDARD FORMS

First Aid (NTRP 4-02.1; AFMAN 44-163)	FM 4-25.11
Product Quality Deficiency Report (NSN 7540-00-133-5541) (This Item is Included on EM 0001)	SF Form 368
Recommended Changes to Publications and Blank Forms (This Item is Included on EM 0001)	DA Form 2028

TECHNICAL MANUALS.

Direct Support and General Support Maintenance Manual for Engine, W/Container: Turbosupercharged, Diesel, Fuel Injection, 90 Degree, V-Type, Air Cooled, 12 Cylinder, Assembly (Models AVDS-1790-2c) (NSN 2815-00-410-1203), (Model AVDS-1790-2d) (2815-00-410-1204), (Model AVDS-1790-2dr) (2815-00-124-5387), (Model AVDS-1790-2ca) (2815-01-149-1353) and (Model AVDS 1790-2da) (2815-01-166-2051) (Reprinted W/Basic Incl C1-5) (This Item is Included on EM 0036, EM 0044 & EM 0063)	TM 9-2815-220-34
Direct Support and General Support Maintenance Repair Parts and Special Tools List (Including Depot Maintenance Repair Parts and Special Tools) for Engine With Container; Turbosupercharged, Diesel, Fuel Injection, 90-Degree "V" Type, Air-Cooled, 12-Cylinder, Assembly; Models AVDS-1790-2dr, (NSN 2815-00-124-5387) AVDS-1790-2ca, (2815-01-149-1353) and AVDS-1790-2da, (2815-01-166-2051) (This Item is Included on EM 0036, EM 0044 & EM 0063)	TM 9-2815-220-34P
Materials Used for Cleaning, Preserving, Abrading and Cementing Ordnance Materiel and Related Materials Including Chemicals	TM 9-247
Operator's Manual: Operator Controls and PMCS for Tank, Combat, Full Tracked: 105-MM Gun, M60A1 (NSN 2350-00-756-8497) and M60A1 (AOS) (2350-01-058-9487) (Reprinted W/Basic Incl C1-5)	TM 9-2350-215-10-1
Operator's Manual Operation Under Usual and Unusual Conditions for Tank, Combat, Full-Tracked: 105-MM Gun, M60A1 (NSN 2350-00-756-8497) Tank, Combat, Full-Tracked: 105-MM Gun, M60A1 (AOS) (2350-01-058-9487) (Reprinted W/Basic Incl C1)	TM 9-2350-215-10-2
Operator's Manual: Troubleshooting and Maintenance for Tank, Combat, Full-Tracked: 105-MM Gun, M60A1 (NSN 2350-00-756-8497) and Tank, Combat, Full-Tracked: 105-MM Gun, M60A1 (AOS) (2350-01-058-9487) (Reprinted W/Basic Incl C1-3)	TM 9-2350-215-10-3

REFERENCE WORK PACKAGE - CONTINUED 0014 00

Organizational Maintenance Manual for Tank, Combat, Full-Tracked: 105-MM Gun, M60A1 (NSN 2350-00-756-8497) (Hull) and M60A1/AOS (2350-01-058-9487) (Hull) (Reprinted W/Basic Incl C1) 105 MM Gun, M60A1 and M60A1/AOS (Hull)	TM 9-2350-215-20-1-2
Organizational Maintenance Manual for Tank, Combat, Full-Tracked: 105-MM Gun, M60A1 (NSN 2350-00-756-8497) (Hull) and M60A1 AOS (2350-01-058-9487) (Hull)	TM 9-2350-215-20-1-3
Organizational Maintenance Manual for Tank, Combat, Full-Tracked: 105-MM Gun, M60A1 (NSN 2350-00-756-8497) (Hull) and M60A1/AOS (2350-01-058-9487) (Hull) (Reprinted W/Basic Incl C1-3)	TM 9-2350-215-20-1-4

SUPPLY CATALOGS

Sets, Kits, and Outfits Shop Equipment, Automotive Maintenance and Repair: Field Maintenance, Basic, Less Power (NSN 4910-00-754-0705) (LIN T24660) (EIC: 2J2)	SC 4910-95-A31
Sets, Kits, Outfits, and Tools for Shop Equipment, Automotive Maintenance and Repair: Field Maintenance, Supplemental Set No. 2, Less Power (NSN 4910-00-754-0707) (Lin T25756) (EIC: 2J4) and Shop Equipment, Automotive Maintenance and Repair: Field Maintenance, Supplemental Set No.2 Map Only	SC 4910-95-A63
SC 9999-01-SKO, Consolidated Publication of Component Lists	EM 0074

PUBLICATION INDEXES

The following indexes should be consulted frequently for latest changes or revisions to references given in the appendix and for new publications relating to material covered in this Technical Manual.

Consolidated Index of Army Publications and Blank Forms (Issued Quarterly) (No Printed Copies Exist) (Formerly DA PAM 310-1)	PAM 25-30
Army Maintenance Management System (TAMMS) Users Manual	PAM 750-8

END OF WORK PACKAGE

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE

REPAIR PARTS AND SPECIAL TOOLS LIST

INTRODUCTION

SCOPE

This Work Package lists repair parts and special tools required for direct and general support maintenance of the Delco-Remy-GMC Electrical Engine Starter Assemblies, part numbers 1109972 and 1990272. It authorizes the requisitioning and issue of repair parts as indicated by the source and maintenance codes.

Part Numbers	Engine Applications
1109972 and 1990272	AVDS-1790-2C
	AVDS-1790-2CA
	AVDS-1790-2D
	AVDS-1790-2DA
	AVDS-1790-2DR

GENERAL

In addition to the introduction, this work package is divided into the following areas.

1. Repair Parts List - A list of repair parts authorized for use in the performance of maintenance. This work package also includes parts which must be removed for replacement of the authorized parts. Parts lists are composed of functional groups in ascending alphanumeric sequence, with the parts in each group listed in ascending figure and item number sequence.
2. Special Tools List – No special tools are required.
3. Cross-Reference Index - There are two cross-reference indexes in this work package: the National Stock Number (NSN) and the Part Number (P/N) index. The National Stock Number Index refers you to the figure and item number. The Part Number Index refers you to the figure and item number.

EXPLANATION OF COLUMNS IN THE REPAIR PARTS AND SPECIAL TOOLS LIST

ITEM NO. (Column (1). Indicates the number used to identify items called out in the illustration.

SMR CODE (Column (2). The SMR code containing supply/requisitioning information, maintenance level authorization criteria, and disposition instruction, as shown in the following breakout:

Source Code XXxxx	Maintenance Code xxXXx		Recoverability Code xxxxX
1st two positions: How to get an item.	3rd position: Who can install, replace, or use the item.	4th position: Who can do complete repair* on the item.	5th position: Who determines disposition action on unserviceable items.

*Complete Repair: Maintenance capacity, capability, and authority to perform all corrective maintenance tasks of the "Repair" function in a use/user environment in order to restore serviceability to a failed item.

Source Code. The source code tells you how you get an item needed for maintenance, repair, or overhaul of an end item/equipment. Explanations of source codes follow:

Source Code	Application/Explanation
PA PB PC PD PE PF PG	Stock items; use the applicable NSN to requisition/request items with these source codes. They are authorized to the level indicated by the code entered in the 3rd position of the SMR code. **NOTE** Items coded PC are subject to deterioration.

Source Code	Application/Explanation
KD KF KB	Items with these codes are not to be requested/requisitioned individually. They are part of a kit which is authorized to the maintenance level indicated in the 3rd position of the SMR code. The complete kit must be requisitioned and applied.
MO-Made at unit/ AVUM level MF-Made at DS/ AVILM level MH-Made at GS level ML-Made at SRA MD-Made at depot	Items with these codes are not to be requisitioned/requested individually. They must be made from bulk material which is identified by the P/N in the DESCRIPTION AND USABLE ON CODE (UOC) column and listed in the bulk material group work package of the RPSTL. If the item is authorized to you by the 3rd position code of the SMR code, but the source code indicates it is made at higher level, order the item from the higher level of maintenance.
AO-Assembled by unit/AVUM level AF-Assembled by DS/AVIM level AH-Assembled by GS level AL-Assembled by SRA AD-Assembled by depot	Items with these codes are not to be requested/requisitioned individually. The parts that make up the assembled item must be requisitioned or fabricated and assembled at the level of maintenance indicated by the source code. If the 3rd position of the SMR code authorizes you to replace the item, but the source code indicates the item is assembled at a higher level, order the item from the higher level of maintenance.
XA	Do not requisition an "XA" coded item. Order the next higher assembly. (Refer to NOTE below.)
XB	If an item is not available from salvage, order it using the CAGEC and P/N.
XC	Installation drawings, diagrams, instruction sheets, field service drawings; identified by manufacturer's P/N.
XD	Item is not stocked. Order an XD-coded item through normal supply channels using the CAGEC and P/N given, if no NSN is available.

NOTE

Cannibalization or controlled exchange, when authorized, may be used as a source of supply for items with the above source codes except for those items source coded "XA" or those aircraft support items restricted by requirements of AR 750-1.

Maintenance Code. Maintenance codes tell you the level(s) of maintenance authorized to use the repair support items. The maintenance codes are entered in the third and fourth positions of the SMR code as follows:

Third Position. The maintenance code entered in the third position tells you the lowest maintenance level authorized to remove, replace, and use an item. The maintenance code entered in the third position will indicate authorization to the following levels of maintenance:

Maintenance Code		Application/Explanation
C	-	Crew or operator maintenance done within unit/AVUM maintenance.
O	-	Unit level/AVUM maintenance can remove, replace, and use the item.
F	-	Direct support/AVIM maintenance can remove, replace, and use the item.

Maintenance Code		Application/Explanation
H	–	General support maintenance can remove, replace, and use the item.
L	–	Specialized repair activity can remove, replace, and use the item.
D	–	Depot can remove, replace, and use the item.

Fourth Position. The maintenance code entered in the fourth position tells you whether or not the item is to be repaired and identifies the lowest maintenance level with the capability to do complete repair (perform all authorized repair functions).

NOTE

Some limited repair may be done on the item at the lower level of maintenance, if authorized by the SMR codes.

Maintenance Code		Application/Explanation
O	–	Unit/AVUM is the lowest level that can do complete repair of the item.
F	–	Direct support/AVIM is the lowest level that can do complete repair of the item.
H	–	General support is the lowest level that can do complete repair of the item.
L	–	Specialized repair activity is the lowest level that can do complete repair of the item.
D	–	Depot is the lowest level that can do complete repair of the item.
Z	–	Nonreparable. No repair is authorized.
B	–	No repair is authorized. No parts or special tools are authorized for maintenance of "B" coded item. However, the item may be reconditioned by adjusting, lubricating, etc., at the user level.

Recoverability Code. Recoverability codes are assigned to items to indicate the disposition action on unserviceable items. The recoverability code is shown in the fifth position of the SMR code as follows:

Recoverability Code		Application/Explanation
Z	–	Nonreparable item. When unserviceable, condemn and dispose of the item at the level of maintenance shown in the third position of the SMR code.
O	–	Reparable item. When uneconomically reparable, condemn and dispose of the item at the unit level.
F	–	Reparable item. When uneconomically reparable, condemn and dispose of the item at the direct support level.
H	–	Reparable item. When uneconomically reparable, condemn and dispose of the item at the general support level.
D	–	Reparable item. When beyond lower level repair capability, return to depot. Condemnation and disposal of item is not authorized below depot level.
L	–	Reparable item. Condemnation and disposal not authorized below Specialized Repair Activity (SRA).
A	–	Item requires special handling or condemnation procedures because of specific reasons (such as precious metal content, high dollar value, critical material, or hazardous material). Refer to appropriate manuals/directives for specific instructions.

NSN (Column (3)). The NSN for the item is listed in this column.

CAGEC (Column (4)). The Commercial and Government Entity Code (CAGEC) is a five-digit code which is used to identify the manufacturer, distributor, or Government agency/activity that supplies the item.

PART NUMBER (Column (5)). Indicates the primary number used by the manufacturer (individual, company, firm, corporation, or Government activity), which controls the design and characteristics of the item by means of its engineering drawings, specifications, standards, and inspection requirements to identify an item or range of items.

NOTE

When you use an NSN to requisition an item, the item you receive may have a different P/N from the number listed.

DESCRIPTION AND USABLE ON CODE (UOC) (Column (6)). This column includes the following information:

1. The federal item name, and when required, a minimum description to identify the item.

2. P/Ns of bulk materials are referenced in this column in the line entry to be manufactured or fabricated.
3. Hardness Critical Item (HCI). A support item that provides the equipment with special protection from Electromagnetic Pulse (EMP) damage during a nuclear attack.
4. The statement END OF FIGURE appears just below the last item description in column (6) for a given figure in both the repair parts list and special tools list.

QTY (Column (7)). The QTY (quantity per figure) column indicates the quantity of the item used in the breakout shown on the illustration/figure, which is prepared for a functional group, subfunctional group, or an assembly. A "V" appearing in this column instead of a quantity indicates that the quantity is variable and quantity may change from application to application.

EXPLANATION OF CROSS-REFERENCE INDEX FORMAT AND COLUMNS

1. National Stock Number (NSN) Index.

STOCK NUMBER Column. This column lists the NSN in National Item Identification Number (NIIN) sequence. The NIIN consists of the last nine digits of the NSN.

NSN (e.g., 5385-01-574-1476) NIIN	When using this column to locate an item, ignore the first four digits of the NSN. However, the complete NSN should be used when ordering items by stock number.

FIG. Column. This column lists the number of the figure where the item is identified/located. The figures are in numerical order in the repair parts list and special tools list.

ITEM Column. The item number identifies the item associated with the figure listed in the adjacent FIG. column. This item is also identified by the NSN listed on the same line.

2. Part Number (P/N) Index. P/Ns in this index are listed in ascending numeric-alpha sequence (vertical arrangement of number and letter combinations which places the first digit or letter of each group in order 0 through 9, followed by the letters A through Z and each following digit or letter in like order).

PART NUMBER Column. Indicates the P/N assigned to the item.

FIG. Column. This column lists the number of the figure where the item is identified/located in the repair parts list and special tools list.

ITEM Column. The item number is in the number assigned to the item as it appears in the figure referenced in the adjacent figure number column.

SPECIAL INFORMATION

UOC. The UOC appears in the lower left corner of the Description Column heading. Usable on codes are shown as "UOC:…" in the Description Column (justified left) on the first line under the applicable item/nomenclature. Uncoded items are applicable to all models.

Fabrication Instructions. Detailed fabrication instructions for items source coded to be manufactured or fabricated are found in WP 0013 00.

Item Numbers. Items which have the word BULK in the figure column will have an index number shown in the item number column. This index number is a cross-reference between the NSN / P/N index and the bulk material list in the repair parts list.

Repair Parts Kits. Repair parts kits appear as the last entries in the repair parts listing for the figure in which its parts are listed as repair parts.

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

HOW TO LOCATE REPAIR PARTS

1. When NSNs or P/Ns are not known.
   A. Using the table of contents, determine the assembly group to which the item belongs. This is necessary since figures are prepared for assembly groups and subassembly groups, and lists are divided into the same groups.

B. Find the figure covering the functional group or the subfunctional group to which the item belongs.

C. Identify the item on the figure and note the number(s).

D. Look in the repair parts list work packages for the figure and item numbers. The NSNs and part numbers are on the same line as the associated item numbers.

2. When NSN is known.

A. If you have the NSN, look in the Stock Number column of the NSN index. The NSN is arranged in NIIN sequence. Note the figure and item number next to the NSN.

B. Turn to the figure and locate the item number. Verify that the item is the one you are looking for.

3. When P/N is known.

A. If you have the P/N and not the NSN, look in the Part Number column of the P/N index. Identify the figure and item number.

B. Look up the item on the figure in the applicable repair parts list.

ABBREVIATIONS

Abbreviation	Explanation
FIG	Figure
NSN	National Stock Number
RPSTL	Repair Parts and Special Tools List
SMR	Source, Maintenance, and Recoverability
TMDE	Test, Measurement, and Diagnostic Equipment
UOC	Usable on Code

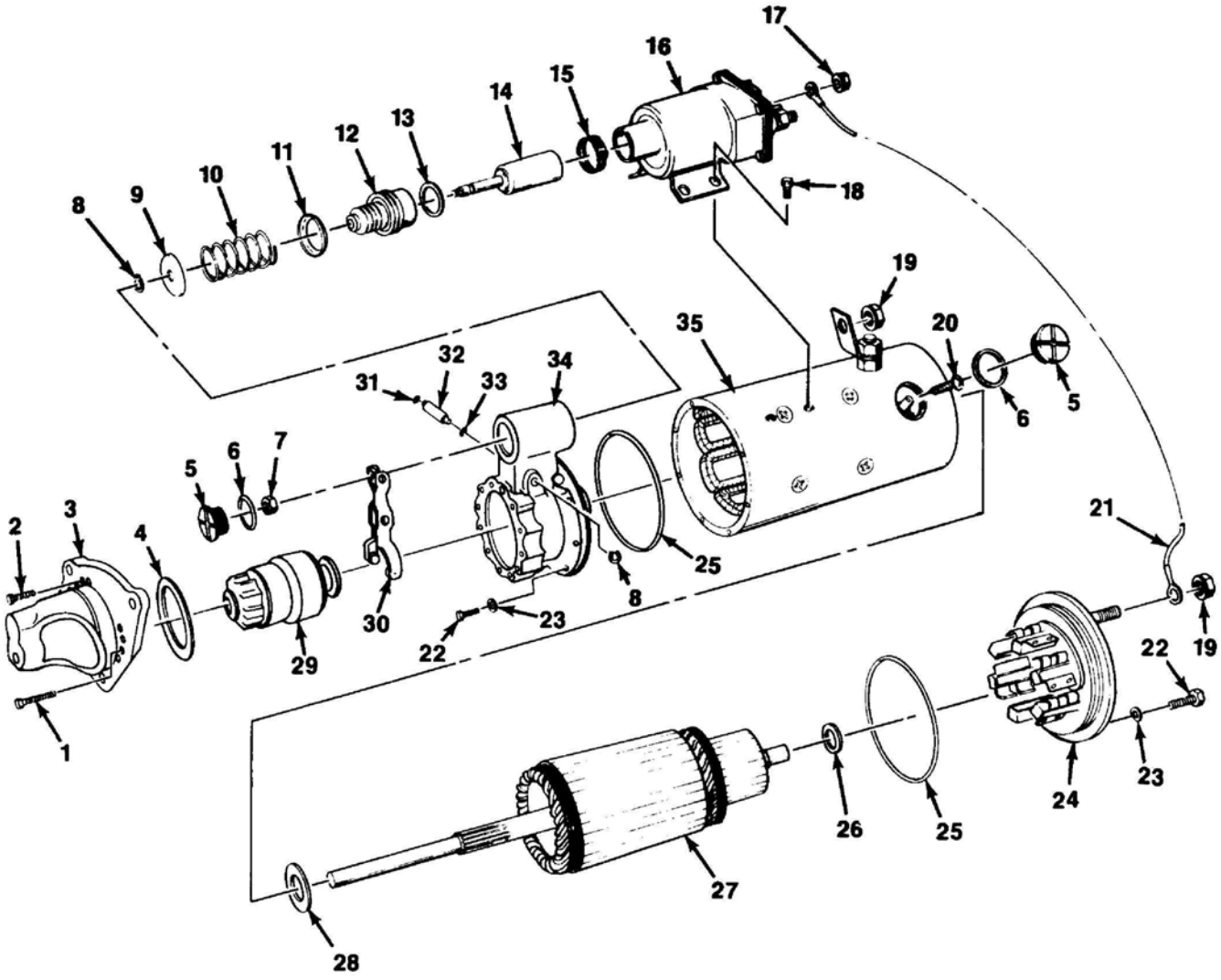


Figure 1. Starter Assembly.

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
					GROUP 0603 STARTER ASSEMBLY, DELCO REMY-GMC PART NO 1109972, 1990272	
					FIGURE 1 STARTER ASSEMBLY	
1	PAFZZ	5306-00-783-5183	16764	1948536	BOLT INTERNAL WRENCHING: DRIVE HOUSING TO LEVER HOUSING, PART OF KIT P/N 5702709	5
2	PAFZZ	5306-00-783-5188	16764	1948537	BOLT INTERNAL WRENCHING: DRIVE HOUSING TO LEVER HOUSING, PART OF KIT P/N 5702709	1
3	PAFFH	2920-01-138-7045	16764	1957846	STARTER HOUSING, ENGINE: DRIVE SEE FIG. 2	1
4	PAFZZ	5330-00-842-1901	19207	7748635	GASKET: DRIVE HOUSING, PART OF KIT P/N 5702709	1
5	PAFZZ	5365-00-753-9528	16764	1945356	PLUG, MACHINE THREAD: LEVER HOUSING IN-SPECTION (1), FRAME(3)	4
6	PAFZZ	5330-00-914-0703	16764	1964857	GASKET: LEVER HOUSING INSPECTION PLUG (1), FRAME PLUG (3), PART OF KIT P/N 5702709	4
7	PAFZZ	5310-00-965-6000	16764	9412305	NUT, SELF-LOCKING, HEXAGON: PLUNGER ROD GUIDE ADJUSTING	1
8	PAFZZ	5365-00- 715-1152	96906	MS16624-1037	RING, RETAINING: RELAY PLUNGER (1) SHIFT LEVER SHAFT (1), PART OF KIT P/N 5702706 AND 5702709	2
9	PAFZZ	5310-00-822-2241	16764	1948526	WASHER, RECESSED: RELAY PLUNGER SPRING RETAINER, FRONT	1
10	PAFZZ	5360-00-812-0196	19207	7748643	SPRING, HELICAL, COMPRESSION: RELAY PLUNGER, PART OF KIT P/N 5702706	1
11	PAFZZ	5310-00-822-2236	16764	1948520	WASHER, RECESSED: RELAY PLUNGER SPRING RETAINER, REAR	1
12	PAFZZ	2920-00-839-1864	19207	7748637	BELLOWS, PROTECTION: RELAY PLUNGER, PART OF KIT P/N 5702706	1
13	PAFZZ	5310-00-062-2051	16764	1948519	WASHER, FLAT: RELAY PLUNGER SPRING RE-TAINER	1
14	PAFZZ	2920-00-822-2287	16764	1948522	PLUNGER ASSEMBLY: RELAY.....	1
15	PAFZZ	4730-00-277-6320	16764	801078	CLAMP, HOSE: RELAY PLUNGER BELLOWS, PART OF KIT P/N 5702706	1
16	PAFFF	2920-00-445-0865	16764	1115563	RELAY, ELECTROMAGNET: SEE FIG. 3	1
17	PAFZZ	5310-01-144-3121	16764	1979365	NUT, PLAIN, ASSEMBLED WASHER: LEAD TO RELAY	1
18	PAFZZ	5306-00-550-3023	81348	FFB575	BOLT, MACHINE: RELAY TO FRAME, PART OF KIT P/N 5702706	4
19	PAFZZ	5310-01-118-2476	16764	1979451	NUT, PLAIN, EXTENDED WASHER HEXAGON: RELAY TO FRAME (1), LEAD TO COMMUTATOR END PLATE (1)	2
20	PAFZZ	5305-00-432-8422	16764	1968998	SCREW, TAPPING, FIELD COIL LEAD TO BRUSH HOLDER	3
21	PAFZZ	2590-01-140-9058	16764	1979600	LEAD ASSEMBLY, ELECTRICAL: COMMUTATOR END TO RELAY	1
22	PAFZZ	5305-00-068-0515	96906	MS90727-8	SCREW, CAP, HEXAGON HEAD: COMMUTATOR END PLATE (6), LEVER HOUSING TO FRAME (7)	13
23	PAFZZ	5310-00-582-5965	96906	MS35338-44	WASHER, LOCK: COMMUTATOR END PLATE	13
24	AFFFH		16764	1985002	PLATE, COMMUTATOR END: COMPLETE, SEE FIG. 4	1

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
25	PAFZZ	5330-01-024-9686	16764	1945860	PACKING, PREFORMED: COMMUTATOR END PLATE (1), LEVER HOUSING (1), PART OF KIT P/N 5702708	2
26	PAFZZ	5310-00-827-2821	19207	7748630	WASHER, FLAT: ARMATURE, COMMUTATOR END	1
27	PAFZZ	2920-00-825-4563	19207	7748629	ARMATURE, MOTOR	1
28	PAFZZ	2920-00-999-2527	16764	1936466	WASHER: SPACE BETWEEN LEVER HOUSING	1
29	PAFZZ	2920-01-138-7194	16764	1976884	DRIVE, ENGINE, ELECTRICAL: CLUTCH AS-SEMBLY	1
30	PAFZZ	6110-00-757-7187	16764	1945484	LEVER ASSEMBLY: SHIFT	1
31	PAFZZ	5330-01-053-2907	16764	1894643	PACKING, PREFORMED: SHIFT LEVER SHAFT, PART OF KIT P/N 5702708	1
32	PAFZZ	2920-00-034-4216	16764	1948529	SHAFT, SHOULDERED: SHIFT LEVER	1
33	PAFZZ	5330-01-053-7021	16764	1894642	PACKING, PREFORMED: SHIFT LEVER SHAFT, PART OF KIT P/N 5702708	1
34	AFFFH		16764	1979870	HOUSING ASSEMBLY: LEVER, SEE FIG. 6 FOR PARTS BREAKOUT	1
35	XAFZZ		16764	1985109-1	FRAME AND FIELD ASSEMBLY, SEE FIG. 7 FOR PARTS BREAKOUT	
	PAFZZ	292 0-00-089-3367	19207	5702706	PARTS KIT, ELECTRICAL ENGINE STARTER: RELAY	
					COMPOSED OF:	
					RING, RETAINING	1
					SPRING, HELICAL COMPRESSION	1
					BELLOWS, PROTECTION	1
					CLAMP, HOSE	1
					BOLT, MACHINE	4

END OF FIGURE

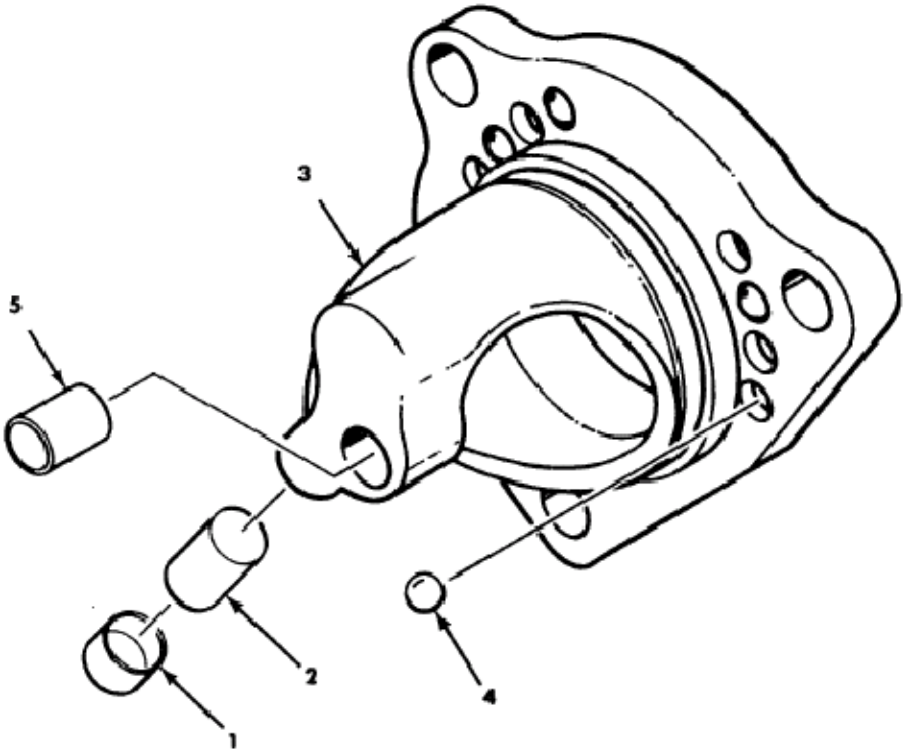


Figure 2. Drive End Housing Assembly.

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
					GROUP 0603 STARTER ASSEMBLY, DELCO REMY-GMC PART NO 1109972, 1990272 - CONTINUED	
					FIGURE 2 DRIVE END HOUSING ASSEMBLY	
1	PAFZZ	5340-01-115-3548	16764	1978756	CAP, PROTECTIVE, DUST AND MOISTURE SEAL: OIL RESERVOIR PART OF KIT P/N 5705272	1
2	PAFZZ	2920-01-112-3500	16764	1978754	WICK: BUSHING SLEEVE OILER, PART OF KIT P/N 5705272	1
3	XAFZZ		16764	1957846-1	HOUSING	1
4	PAFZZ	9320-00-757-7131	16764	1949619	BALL, RUBBER: DRIVE HOUSING MOUNTING HOLE	6
5	PAHZZ	3120-00-828-6852	16764	1894635	BUSHING, SLEEVE: DRIVE HOUSING	
			END OF FIGURE			

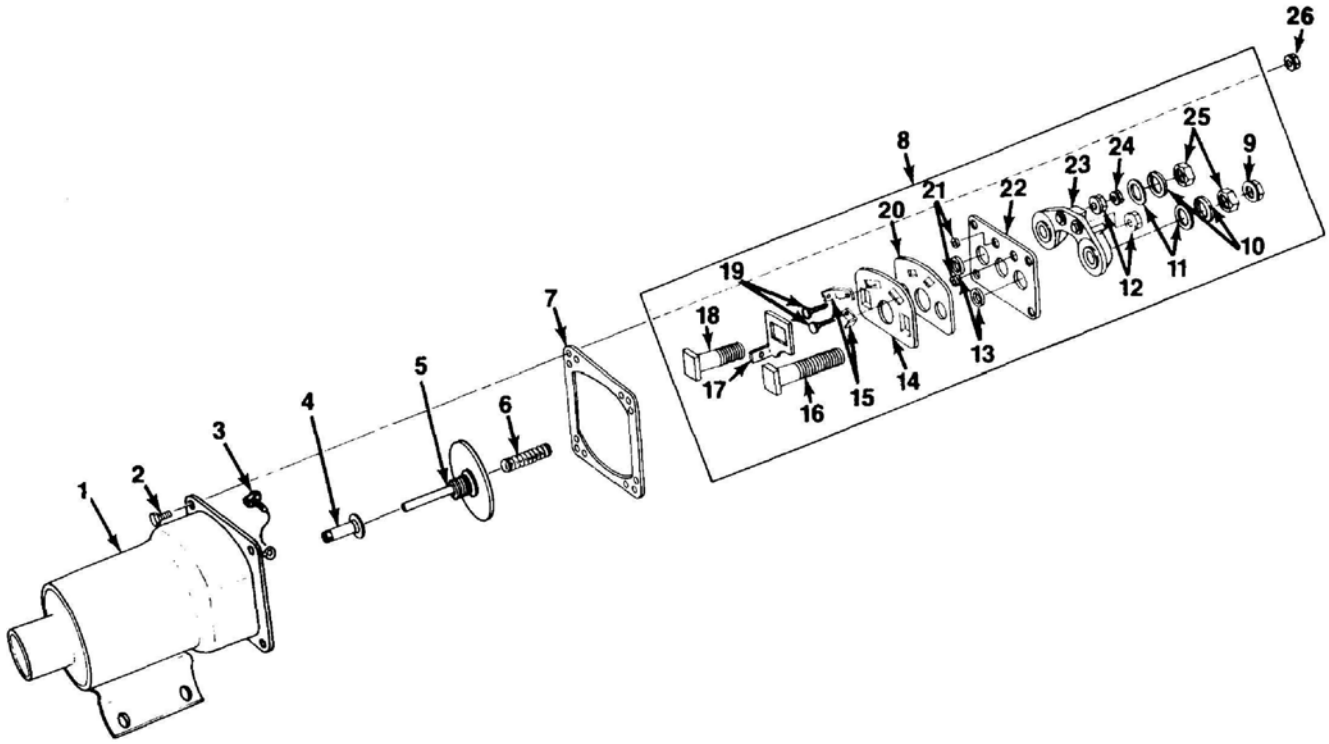


Figure 3. Solenoid Assembly.

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
					GROUP 0603 STARTER ASSEMBLY, DELCO REMY-GMC PART NO 1109972, 1990272 - CONTINUED	
					FIGURE 3 SOLENOID ASSEMBLY	
1	XAFZZ		16764	1979495	CASE AND COIL ASSEMBLY	1
2	PAFZZ	5306-00-042-5883	24617	425883	BOLT, ASSEMBLED WASHER: TERMINAL BOARD ATTACHING	4
3	PAFZZ	5305-00-423-4909	16764	1840633	SCREW, MACHINE: COIL LEAD	3
4	PAFZZ	3120-01-166-8144	16764	1972716	BEARING: PLUNGER ROD GUIDE	1
5	PAFZZ	2920-01-140-0116	16764	1977264	CONTACT ASSEMBLY, ELECTRICAL: STARTER RELAY	1
6	PAFZZ	5360-00-985-2253	16764	1945402	SPRING, HELICAL, COMPRESSION: CONTACT RETURN	1
7	PAFZZ	5330-01-145-3167	16764	1979384	GASKET: TERMINAL BOARD	1
8	PAFFF	5940-01-138-4843	16764	1979541	TERMINAL BOARD: STARTER RELAY	1
9	PAFZZ	5310-01-118-2476	16764	1979451	NUT, PLAIN, EXTENDED WASHER, HEXAGON: TERMINAL STUD	1
10	PAFZZ	5310-00-584-5272	96906	MS35338-48	WASHER, LOCK: TERMINAL STUD	2
11	PAFZZ	5310-00-167-0839	88044	AN960-816L	WASHER, FLAT: TERMINAL STUD	2
12	KFFZZ		16764	1979366	NUT, ASSEMBLED WASHER PART OF KIT P/N 1979776	2
13	PAFZZ	2920-00-999-2399	16764	1942969	BUSHING, STARTER: TERMINAL STUD INSULATOR	2
14	PAFZZ	5970-01-159-9698	16764	1979369	INSULATOR, PLATE: TERMINAL STUD	1
15	KFFZZ		16764	1979373	TERMINAL, PART OF KIT P/N 1979776:	2
16	PAFZZ	2920-00-999-2535	16764	1953244	TERMINAL: BATTERY	1
17	XDFZZ	5940-00-581-6291	16764	1906051	TERMINAL, LUG: MOTOR	1
18	PAFZZ	5940-00-871-0944	16764	1906049	TERMINAL, STUD: MOTOR	1
19	KFFZZ		16764	1979371	TERMINAL: PART OF KIT P/N 1979776	1
20	PAFZZ	5970-01-159-9699	16764	1979368	INSULATOR, PLATE: TERMINAL STUD	1
21	KFFZZ		16764	1979374	BUSHING: PART OF KIT P/N 1979776	2
22	XAFZZ		16764	1979542	PLATE: TERMINAL	1
23	PAFZZ	5970-01-150-1446	16764	1984705	INSULATOR: TERMINAL STUD	1
24	PAFZZ	5310-01-144-3121	16764	1979365	NUT, PLAIN, ASSEMBLED WASHER: PART OF KIT P/N 1979776	1
25	PAFZZ	5310-00-834-8732	96906	MS35691-33	NUT, PLAIN, HEXAGON: TERMINAL STUD	2
26	PAFZZ	5310-01-144-3121	16764	1979365	NUT, PLAIN, ASSEMBLED WASHER TERMINAL BOARD ATTACHING	4
	PAFZZ	2920-01-138-4859	16764	1979776	PARTS KIT, ELECTRICAL ENGINE STARTER: SWITCH AND GROUND TERMINAL, ...	2
					COMPOSED OF:	
12					NUT, ASSEMBLED WASHER	2
15					TERMINAL	2
19					TERMINAL	2
21					BUSHING, TERMINAL	2
24					NUT, PLAIN, ASSEMBLED WASHER	1
				END OF FIGURE		

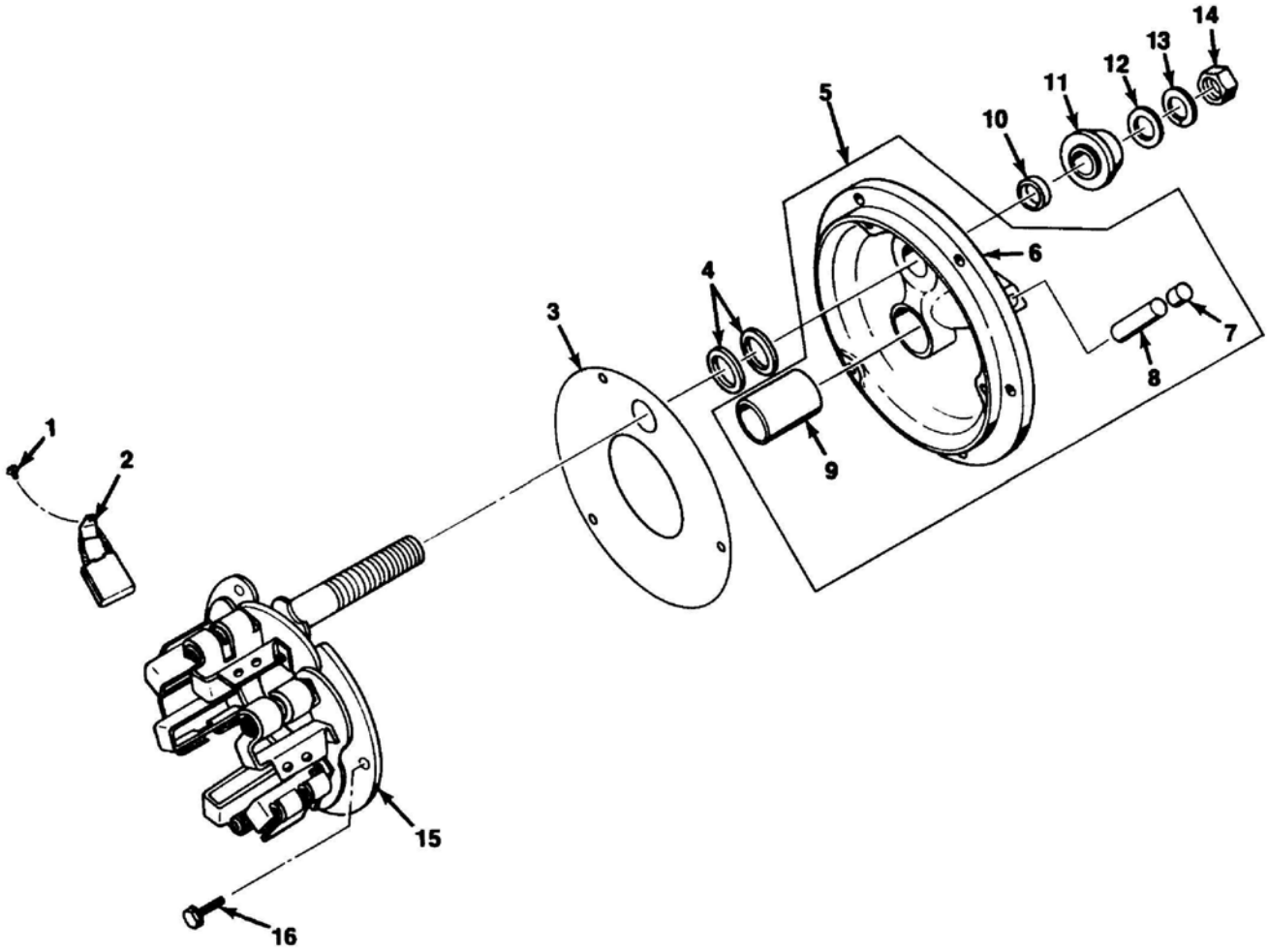


Figure 4. Commutator End Plate Assembly.

GROUP 0603 STARTER ASSEMBLY, DELCO REMY-GMC PART NO 1109972, 1990272 - CONTINUED
FIGURE 4 COMMUTATOR END PLATE ASSEMBLY

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
1	PAFZZ	5305-00-432-8422	16764	1968998	SCREW, TAPPING: BRUSH LEAD ATTACHING ...	6
2	KFFZZ		16764	1852888	BRUSH, ELECTRICAL CONTACT PART OF KIT P/N 5705071	6
3	PAFZZ	5970-00-557-8747	16764	1964516	INSULATOR, BRUSH PLATE	1
4	PAFZZ	5310-00-734-8959	16764	1913084	WASHER FLAT, INSULATED: TERMINAL STUD, PART OF KIT P/N 5702726	2
5	PAFFH	2920-01-138-7046	16764	1945848	STARTER HOUSING, ENGINE: HOUSING COMMUTATOR END	1
6	XAFZZ		16764	1945848-1	HOUSING, COMMUTATOR END	1
7	PAFZZ	5340-01-115-3548	16764	1978756	CAP, PROTECTIVE, DUST AND MOISTURE SEAL: OIL RESERVOIR, PART OF KIT P/N 5705272	1
8	PAFZZ	2920-01-128-8840	16764	1972977	WICK: BEARING SLEEVE OILER, PART OF KIT P/N 5705272	1
9	PAHZZ	3120-01-101-5088	16764	1894638	BEARING, SLEEVE: COMMUTATOR END	1
10	PAFZZ	5330-01-011-4612	16764	1851604	PACKING, PREFORMED: TERMINAL STUD, PART OF KIT P/N 5702726	1
11	PAFZZ	2920-00-100-3403	16764	1944841	INSULATOR, BOWL: TERMINAL STUD	1
12	PAFZZ	5310-00-167-0839	88044	AN960-816L	WASHER, FLAT: TERMINAL STUD	1
13	PAFZZ	5310-00-584-5272	96906	MS35338-48	WASHER, LOCK: TERMINAL STUD	1
14	PAFZZ	5310-00-834-8732	96906	MS35691-33	NUT, PLAIN, HEXAGON: TERMINAL STUD	1
15	PAFFH	5977-01-138-7043	16764	1985066	BRUSH PLATE ASSEMBLY: SEE FIG. 5 FOR PARTS BREAKOUT	1
16	PAFZZ	5305-00-218-6387	16764	1847807	SCREW, MACHINE: BRUSH PLATE ASSEMBLY TO COMMUTATOR END HOUSING	3

END OF FIGURE

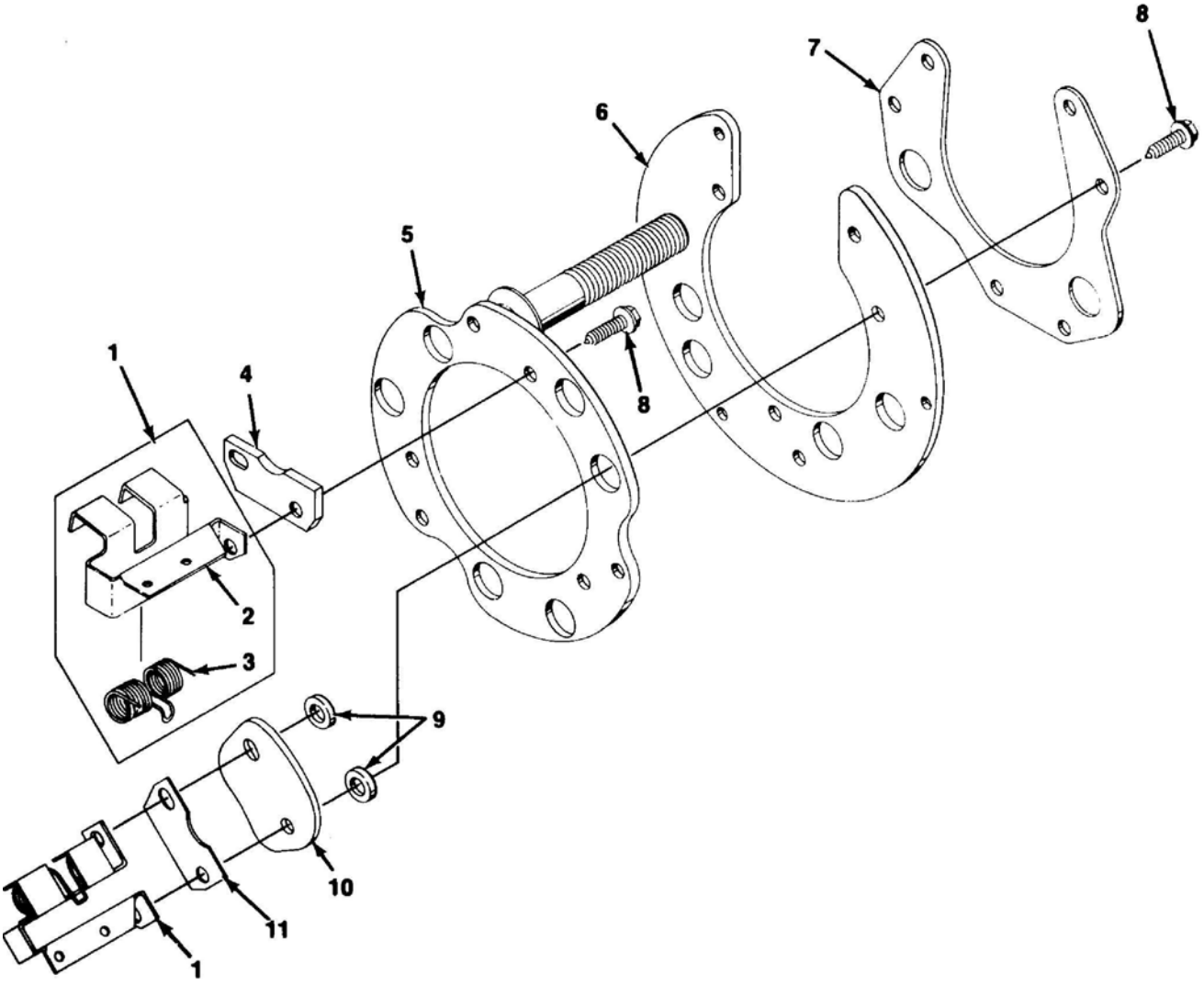


Figure 5. Brush Plate Assembly.

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
					GROUP 0603 STARTER ASSEMBLY, DELCO REMY-GMC PART NO 1109972, 1990272 – CONTINUED	
					FIGURE 5 BRUSH PLATE ASSEMBLY	
1	PAFZZ	5977-01-153-0322	16764	1984979	HOLDER, ELECTRICAL CONTACT	6
2	XAFZZ		16764	1984980	HOLDER, ELECTRICAL CONTACT	6
3	KFFZZ		16764	1979391	SPRING, HELICAL, TORSION BRUSH HOLDER, PART OF KIT P/N 5705071	6
4	PAFZZ	5977-01-137-3421	16764	1979388	PLATE, GROUND HOLDER	3
5	XAFZZ		16764	1985067	TERMINAL AND PLATE ASSEMBLY	1
6	PAFZZ	5970-01-138-7044	16764	1984978	PLATE, INSULATOR, STARTER: BRUSH	1
7	XAFZZ		16764	1984981	PLATE, SUPPORT, HOLDER	1
8	PAFZZ	5305-01-136-5560	16764	1972776	SCREW AND WASHER: BRUSH HOLDER TO TERMINAL PLATE	12
9	PAFZZ	5310-00-291-4498	16764	1913080	WASHER, FLAT: BRUSH HOLDER INSULATOR PLATE	6
10	PAFZZ	5970-00-918-5568	16764	1965093	INSULATOR, PLATE: BRUSH HOLDER	3
11	PAFZZ	5970-01-137-3420	16764	1979389	PLATE, INSULATOR HOLDER	3
	PAFZZ	2920-01-138-4860	19207	5705071	PARTS KIT, ELECTRICAL ENGINE STARTER ...	1
					COMPOSED OF:	
2					BRUSH, ELECTRICAL CONTACT	6
3					SPRING, HELICAL, TORSION	6

END OF FIGURE

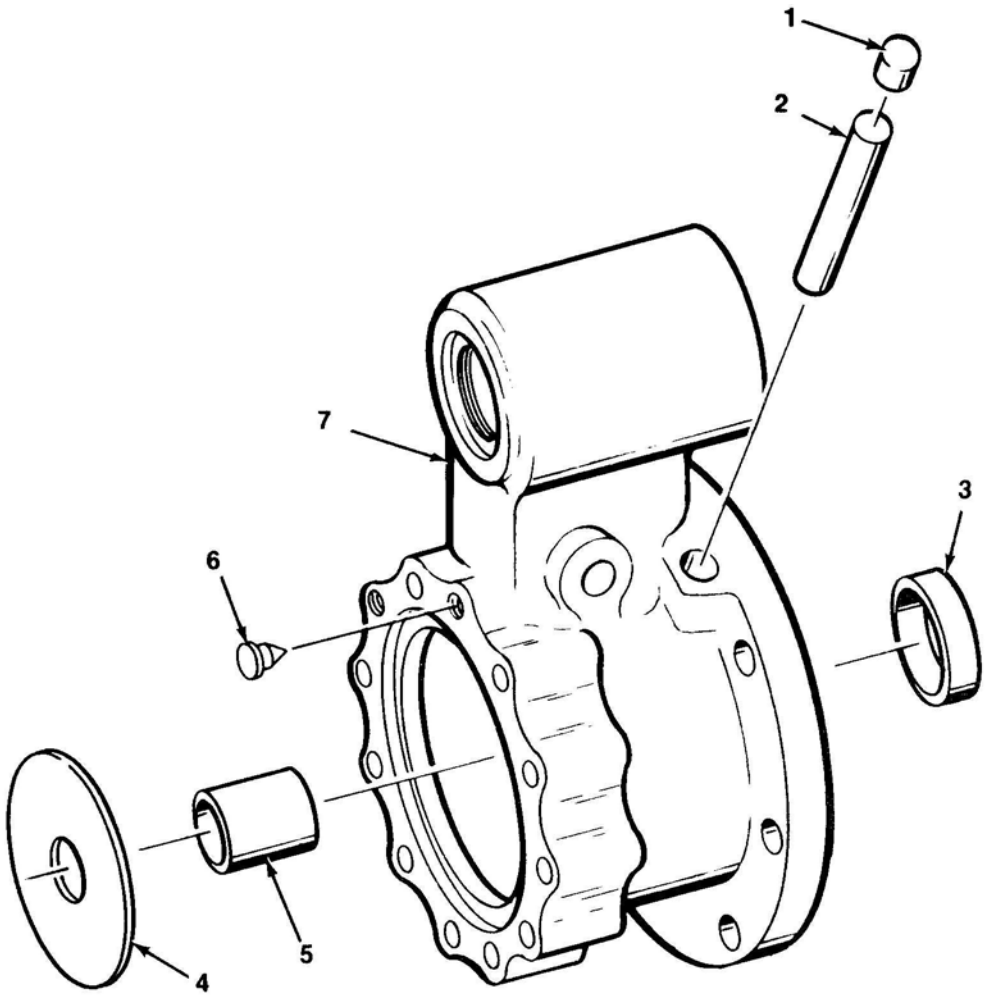


Figure 6. Lever Housing Assembly.

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
					GROUP 0603 STARTER ASSEMBLY, DELCO REMY-GMC PART NO 1109972, 1990272 – CONTINUED	
					FIGURE 6 LEVER HOUSING ASSEMBLY	
1	PAFZZ	5340-01-115-3548	16764	1978756	CAP, PROTECTIVE, DUST AND MOISTURE SEAL: OIL RESERVOIR, PART OF KIT P/N 5705272	1
2	PAFZZ	2920-01-112-3500	16764	1978754	WICK: BEARING SLEEVE OILER, PART OF KIT P/N 5705272	1
3	PAFZZ	5330-01-028-0810	96906	MS51000-109-2	SEAL, PLAIN ENCASED: LEVER HOUSING, PART OF KIT P/N 5702708	1
4	PAFZZ	5310-00-297-7319	16764	1911644	WASHER, FLAT: BRAKE BETWEEN LEVER HOUSING AND DRIVE ASSEMBLY, PART OF KIT P/N 5702709	1
5	PAHZZ	3120-01-101-5089	16764	1894637	BEARING, SLEEVE: LEVER HOUSING	1
6	PAFZZ	5340-01-132-4704	16764	1964402	PLUG: LEVER HOUSING MOUNTING HOLE	1
7	PFFFH	2920-01-167-8124	16764	1945858	HOUSING, ENGINE DRIVE, ELECTRICAL STARTER: LEVER HOUSING	1
	PAFZZ	2920-00-089-3369	19207	5702708	PARTS KIT, ELECTRICAL ENGINE STARTER:	1
					COMPOSED OF:	
4					GASKET	1
6					GASKET	1
25					PACKING, PREFORMED	2
31					PACKING, PREFORMED	1
33					PACKING, PREFORMED	1
3					SEAL, PLAIN, ENCASED	1
	PAFZZ	2920-00-089-3370	19207	5702709	PARTS KIT, ELECTRICAL ENGINE STARTER: THRUST WASHERS,	1
					COMPOSED OF:	
1					BOLT, INTERNAL WRENCHING	5
2					BOLT, INTERNAL WRENCHING	1
8					RING, RETAINING	1
28					WASHER	1
4					WASHER, FLAT	1
	PAFZZ		19207	5705272	PARTS KIT, ELECTRICAL ENGINE STARTER:	1
					COMPOSED OF:	
1					CAP, PROTECTIVE, DUST AND MOISTURE SEAL-	1
2					WICK	1
7					CAP, PROTECTIVE, DUST AND MOISTURE SEAL	1
8					WICK	1
1					CAP, PROTECTIVE, DUST AND MOISTURE SEAL	1
2					WICK	1
			END OF FIGURE			

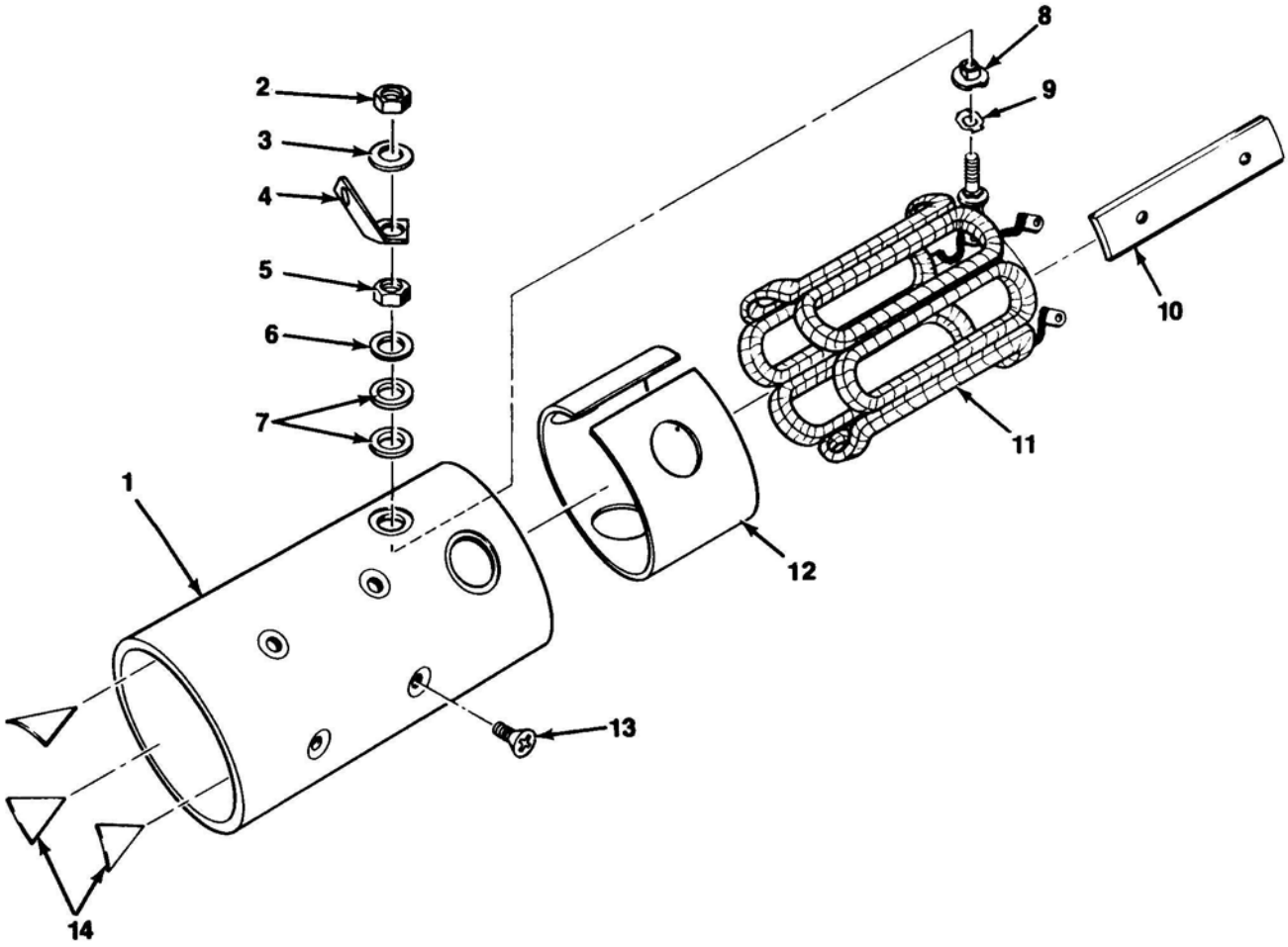


Figure 7. Frame and Field Assembly.

(1) ITEM NO	(2) SMR	(3) NSN	(4) CAGE	(5) PART NUMBER	(6) DESCRIPTION AND USABLE ON CODE (UOC)	(7) QTY
					GROUP 0603 STARTER ASSEMBLY, DELCO REMY-GMC PART NO 1109972, 1990272 – CONTINUED	
					FIGURE 7 FRAME AND FIELD ASSEMBLY	
1	XAFZZ		16764	1985109	FRAME	1
2	PAFZZ	5310-01-118-2476	16764	1979451	NUT, PLAIN, EXTENDED WASHER, HEXAGON: TERMINAL STUD	1
3	PAFZZ	5310-00-584-5272	96906	MS35338-48	WASHER, LOCK: TERMINAL STUD	1
4	PAFZZ	5935-00-401-7527	16764	1953238	BRACKET, ELECTRICAL CONNECTOR TERMINAL STUD	1
5	PAFZZ	5310-00-834-8732	96906	MS35691-33	NUT, PLAIN, HEXAGON: TERMINAL STUD	1
6	PAFZZ	5310-00-167-0839	88044	AN960-816L	WASHER, FLAT: TERMINAL STUD	1
7	PAFZZ	5310-00-719-5470	16764	1922457	WASHER, FLAT: TERMINAL STUD, PART OF KIT P/N 5702726	2
8	KFFZZ		19207	10951389	SUPPORT, INSULATOR: TERMINAL STUD, PART OF KIT P/N 5702726	1
9	KFFZZ		19207	10951388	WASHER, INSULATOR: TERMINAL STUD, PART OF KIT P/N 5702726	1
10	PFFZZ	2920-00-891-0928	16764	1869747	POLE SHOE, STARTER	6
11	PAFZZ	2920-00-993-4233	16764	1945853	WINDING, MOTOR FIELD	1
12	PAFZZ	5970-00-431-3667	16764	1955989	INSULATOR, PLATE: WINDING COMMUTATOR END	1
13	PAFZZ	5305-00-957-2644	96906	MS35191-318	SCREW, MACHINE: POLE SHOE	12
14	PAFZZ	2920-00-737-3225	16764	1914873	PLATE INSULATION: WINDING, DRIVE END	3
	PAFZZ	2920-00-226-1592	19207	5702726	PARTS KIT, ELECTRICAL ENGINE STARTER TERMINAL STUD INSULATOR	1
					COMPOSED OF:	
4					WASHER, FLAT	2
10					PACKING, PREFORMED	1
7					WASHER, FLAT	2
8					SUPPORT INSULATOR	1
9					WASHER INSULATOR	1

END OF FIGURE

CROSS REFERENCE INDEXES
NATIONAL STOCK NUMBER INDEX

NATIONAL STOCK NUMBER	FIGURE NO	ITEM NO
2920-00-034-4216	1	32
5306-00-042-5883	3	2
5310-00-062-2051	1	13
5305-00-068-0515	1	22
2920-00-089-3367	1	KIT
2920-00-089-3369	6	KIT
2920-00-089-3370	6	KIT
2920-00-100-3403	4	11
5310-00-167-0839	3	11
5310-00-167-0839	4	12
5310-00-167-0839	7	6
5305-00-218-6387	4	16
2920-00-226-1592	7	KIT
4730-00-277-6320	1	15
5310-00-291-4498	5	9
5310-00-297-7319	6	4
5935-00-401-7527	7	4
5305-00-423-4909	3	3
5970-00-431-3667	7	12
5305-00-432-8422	1	20
5305-00-432-8422	4	1
2920-00-445-0865	1	16
5306-00-550-3023	1	18
5970-00-557-8747	4	3
5940-00-581-6291	3	17
5310-00-582-5965	1	23
5310-00-584-5272	4	13
5310-00-584-5272	3	10
5310-00-584-5272	7	3
5365-00-715-1152	1	8
5310-00-719-5470	7	7
5310-00-734-8959	4	4
2920-00-737-3225	7	14
5365-00-753-9528	1	5
9320-00-757-7131	2	4
6110-00-757-7187	1	30
5306-00-783-5183	1	1
5306-00-783-5188	1	2
5360-00-812-0196	1	10
5310-00-822-2236	1	11
5310-00-822-2241	1	9
2920-00-822-2287	1	14
2920-00-825-4563	1	27
5310-00-827-2821	1	26
3120-00-828-6852	2	5
5310-00-834-8732	3	25
5310-00-834-8732	4	14
5310-00-834-8732	7	5
2920-00-839-1864	1	12
5330-00-842-1901	1	4
5940-00-871-0944	3	18
2920-00-891-0928	7	10
5330-00-914-0703	1	6
5970-00-918-5568	5	10
5305-00-957-2644	7	13
5310-00-965-6000	1	7
5360-00-985-2253	3	6
2920-00-993-4233	7	11
2920-00-999-2399	3	13
2920-00-999-2527	1	28
2920-00-999-2535	3	16
5330-01-011-4612	4	10
5330-01-024-9686	1	25
5330-01-028-0810	6	3
5330-01-053-2907	1	31
5330-01-053-7021	1	33
3120-01-101-5088	4	9
3120-01-101-5089	6	5
2920-01-112-3500	2	2
2920-01-112-3500	6	2
5340-01-115-3548	2	1
5340-01-115-3548	4	7
5340-01-115-3548	6	1
5310-01-118-2476	1	19
5310-01-118-2476	3	9
5310-01-118-2476	7	2
2920-01-128-8840	4	8
5340-01-132-4704	6	6
5970-01-137-3420	5	11
5977-01-137-3421	5	4
5305-01-136-5560	5	8
5940-01-138-4843	3	8
2920-01-138-4859	3	KIT
2920-01-138-4860	5	KIT
5977-01-138-7043	4	15
5970-01-138-7044	5	6
2920-01-138-7045	1	3
2920-01-138-7046	4	5
2920-01-138-7194	1	29
2920-01-140-0116	2	5
2590-01-140-9058	1	21
5310-01-144-3121	1	17
5310-01-144-3121	3	24
5310-01-144-3121	3	26
5330-01-145-3167	3	7
5970-01-150-1446	3	23
5977-01-153-0322	5	1
5970-01-159-9698	3	14
5970-01-159-9699	3	20
3120-01-166-8144	3	4
2920-01-167-8124	6	7

CROSS REFERENCE INDEXES
PART NUMBER INDEX

PART NUMBER	CAGE	FIGURE NO	ITEM NO
AN960-816L	88044	3	11
AN960-816L	88044	4	12
AN960-816L	88044	7	6
FFB575	81348	1	18
MS16624-1037	96906	1	8
MS35191-318	96906	7	13
MS35338-44	96906	1	23
MS35338-48	96906	3	10
MS35338-48	96906	4	13
MS35338-48	96906	7	3
MS35691-33	96906	3	25
MS35691-33	96906	4	14
MS35691-33	96906	7	5
MS51000-109-2	96906	6	3
MS90727-8	96906	1	22
10951388	19207	7	9
10951389	19207	7	8
1115563	16764	1	16
1840633	16764	3	3
1847807	16764	4	16
1851604	16764	4	10
1852888	16764	4	2
1869747	16764	7	10
1894635	16764	2	5
1894637	16764	6	5
1894638	16764	4	9
1894642	16764	1	33
1894643	16764	1	31
1906049	16764	3	18
1906051	16764	3	17
1911644	16764	6	4
1913080	16764	5	9
1913084	16764	4	4
1914873	16764	7	14
1922457	16764	7	7
1936466	16764	1	28
1942969	16764	3	13
1944841	16764	4	11
1945356	16764	1	5
1945402	16764	3	6
1945484	16764	1	30
1945848	16764	4	5
1945848-1	16764	4	6
1945853	16764	7	11
1945858	16764	6	7
1945860	16764	1	25
1948519	16764	1	13
1948520	16764	1	11
1948522	16764	1	14
1948526	16764	1	9
1948529	16764	1	32
1948536	16764	1	1
1948537	16764	1	2
1949619	16764	2	4
1953238	16764	7	4
1953244	16764	3	16
1955989	16764	7	12
1957846	16764	1	3
1957846-1	16764	2	3
1964402	16764	6	6
1964516	16764	4	3
1964857	16764	1	6
1964857	16764	1	6
1965093	16764	5	10
1968998	16764	1	20
1968998	16764	4	1
1972716	16764	3	4
1972776	16764	5	8
1972977	16764	4	8
1976884	16764	1	29
1977264	16764	3	5
1978754	16764	2	2
1978754	16764	6	2
1978756	16764	2	1
1978756	16764	4	7
1978756	16764	6	1
1979365	16764	1	17
1979365	16764	3	24
1979365	16764	3	26
1979366	16764	3	12
1979368	16764	3	20
1979369	16764	3	14
1979371	16764	3	19
1979373	16764	3	15
1979374	16764	3	21
1979384	16764	3	7
1979388	16764	5	4
1979389	16764	5	11
1979391	16764	5	3
1979451	16764	1	19
1979451	16764	3	9
1979451	16764	7	2
1979495	16764	3	1
1979541	16764	3	8
1979542	16764	3	22
1979600	16764	1	21
1979776	16764	3	KIT
1979870	16764	1	34
1984705	16764	3	23
1984978	16764	5	6
1984979	16764	5	1
1984980	16764	5	2
1984981	16764	5	7
1985002	16764	1	24
1985066	16764	4	15

CROSS REFERENCE INDEXES
PART NUMBER INDEX

PART NUMBER	CAGE	FIGURE NO	ITEM NO
1985067	16764	5	5
1985109	16764	7	1
1985109-1	16764	1	35
425883	24617	3	2
5702706	19207	1	KIT
5702708	19207	6	KIT
5702709	19207	6	KIT
5702726	19207	7	KIT
5705071	19207	5	KIT
5705272	19207	6	KIT
7748629	19207	1	27
7748630	19207	1	26
7748635	19207	1	4
7748637	19207	1	12
7748643	19207	1	10
801078	16764	1	15
9412305	16764	1	7

END OF WORK PACKAGE

EXPENDABLE AND DURABLE ITEMS LIST 0016 00

THIS WORK PACKAGE COVERS:

Scope, Explanation of Columns, and Expendable Supplies and Materials List

INTRODUCTION

Scope

This appendix lists the expendable supplies and materials you will need to operate and maintain the starter. This list is for information only and is not authority to requisition the listed items. These items are authorized to you by CTA 50–970, Expendable/Durable Items (except Medical, Class V, Repair Parts, and Heraldic Items), or CTA 8–100, Army Medical Department Expendable/Durable Items.

Explanation Of Columns In The Expendable / Durable Items List

Column (1) – Item Number. This number is assigned to the entry in the list and is referenced in the narrative instructions to identify the item (e.g. “Use lubricating oil (Item 25, WP 0015 00).

Column (2) – Level. This column identifies the lowest level of maintenance that requires the listed item (F = Direct Support/AVIM, H = General Support).

Column (3) – National Stock Number (NSN). This is the NSN assigned to the item which you can use to requisition it.

Column (4) – Item Name, Description, Commercial and Government Entity Code (CAGEC), and Part Number (P/N). This column provides the other information you need to identify the item.

Column (5) – Unit of Measure (U/M). This code shows the physical measurement or count of an item as issued per the National Stock Number shown in column (3).

EXPENDABLE AND DURABLE ITEMS LIST

Table 1. Expendable and Durable Items List

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) ITEM NAME, DESCRIPTION, CAGE, PART NUMBER	(5) U/M
1		7920-00-205-1711	Rag, Wiping, Cotton, White: 50 lb bale, (80244) DDD-R-30	LB
2		9150-00-231-6689	Lubricating Oil: General Purpose, grade 20 non-detergent, (81349) VV-L-820	QT
3		6850-00-281-1985	Dry-cleaning Solvent: 1 Gallon Can, (81348) P-D-680, Type II	GL
4		7510-00-852-8179	Tape, Adhesive: Type II, 36 Yard Roll, 1 Inch Wide, (81349) MIL-T-22085	RL
5		5350-00-186-8856	Sandpaper: No. 2/0, (80204) ANSI B74.18	PK
6		8030-00-291-1787	Sealing Compound: Type II (81349) MIL-S-45180	PT
7		8010-00-180-6343	Varnish, Electrical Insulating, Impregnating Solvent Containing: (81349) MIL-I-24092, 1 Quart	QT
8		9150-00-985-7247	Grease, Aircraft and Instrument (Gl) (81349) MIL-G-23827	CN
9			Wood Block: 2 X 2 X 6 Inches	
10		7930-00-282-9699	Detergent, General Purpose (81349) MIL-D-16791	GL
11		6850-00-880-7616	Silicone Compound (81343) SAE-A58660	TU
12		7920-00-205-2401	Brush: Hard Bristle, (80204) 7920-00-205-2401	EA
13		4240-00-816-3819	Goggles: Industrial, (80204) ANSI Z87.1	EA
14		8415-00-266-8677	Gloves: Rubber, Industrial (81349) MIL-DTL-32066	PR

Table 1. Expendable and Durable Items List - Continued

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) ITEM NAME, DESCRIPTION, CAGE, PART NUMBER	(5) U/M
15			Wire Probe	EA
16			Measuring Tape	EA

END OF WORK PACKAGE

TOOL IDENTIFICATION LIST 0017 00

THIS WORK PACKAGE COVERS:
Scope, Explanation of Columns, and Tool Identification List

INTRODUCTION

Scope

This work package lists all common tools and supplements and special tools/fixtures needed to maintain the starter.

Explanation Of Columns In The Tool Identification List

Column (1) – Item number. This number is assigned to the entry in the list and is referenced in the initial setup to identify the item (e.g. Extractor (Item 25, WP 0015 00)).

Column (2) – Item Name. This column lists the item by noun nomenclature and other descriptive features (e.g., Gage, belt tension).

Column (3) – National Stock Number. This is the National Stock Number (NSN) assigned to the item; use it to requisition the item.

Column (4) – Part Number. Indicates the primary number used by the manufacturer (individual, company, firm, corporation, or Government activity) which controls the design and characteristics of the item by means of its engineering drawings, specifications, standards, and inspections requirements to identify an item or range of items. The manufacturer's Commercial and Government Entity Code (CAGEC) is also included.

Column (5) – Reference. This column identifies the authorizing supply catalog or RPSTL for items listed in this work package.

TOOL IDENTIFICATION LIST

Table 1. Tool Identification List

(1) ITEM NO.	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER/CAGEC	(5) REFERENCE
1	General mechanic's tool kit	5180-00-177-7033	SC 5180-90-CL-N26 (50980)	SC 5180-90-N26
2	Spring tester 0-10 lbs	6635-00-641-7346	SPT-850285 (64334)	
3	Hacksaw blade	5110-00-277-4591	B94.52M (05047)	
4	Brush spring lifter			WP 0013 00
5	Metal scriber	5120-00-224-9728	83 (73792)	
6	Bearing puller set	5120-00-423-1596		
7	Retaining ring pliers	5120-00-789-0492	GGG-P-480 (81348)	
8	Drill, electrical, portable ¼ in	5130-00-889-8994	W-D-661 (81348)	
9	Bit, drill, 5/32	5133-00-227-9652	B94.11M (05047)	
10	Screw, tapping, thread forming	5305-00-432-4205	FFS107 (81348)	
11	Holder, inserted hammer	5120-00-903-8555	GGG-H-33 (81348)	
12	Face, hammer, inserted	5120-00-596-1071	GGG-H-33 (81348)	
13	Face, hammer, inserted	5120-00-596-1075	5120-00-596-1075 (80204)	
14	Magnifier	6650-00-252-6250	GGM95 (81348)	
15	Extension light	6230-00-729-9259	A-A-60006 (58536)	
16	Caliper, vernier 0-6 in.	5210-01-113-1548	5210-01-113-1548 (80244)	

TOOL IDENTIFICATION LIST - CONTINUED 0017 00

Table 1. Tool Identification List

(1) ITEM NO.	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER/CAGEC	(5) REFERENCE
17	Micrometer 1-2 in.	5210-00-243-2933		
18	Telescope gage set	5120-00-473-9350		
19	Dial indicator	5210-00-223-9648	A-A-2348 (58536)	
20	Wrench set, socket ¼ in. drive	5120-00-081-2305	B107.1 (05047)	
21	Undercutting machine	4940-00-270-1594	MILU17148 (81349)	
22	Threading set, screw	5180-00-448-2362	GGG-T-330 (81348)	
23	Stone, sharpening	5345-00-198-8050	SS-S-736 (81348)	
24	Spring wind tool			WP 0013 00
25	Caliper, micrometer, tube, 0-1 in.	5210-00-293-1683		
26	Caliper, micrometer, outside, 2-6 in.	5210-00-223-9158	GGG-C-105 (80244)	

END OF WORK PACKAGE

ALPHABETICAL INDEX

ALPHABETICAL INDEX – Continued

ALPHABETICAL INDEX - Continued

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS For use of this form, see AR 25–30; the proponent agency is ODISC4.	Use Part II (*reverse)* for Repair Parts and Special Tools Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).	Date
TO: (*Forward to proponent of publication or form) (Include ZIP Code)*	FROM: *(Activity and location) (include ZIP code)*	

PART I – ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS

PUBLICATION/FORM NUMBER	DATE	TITLE
TM 9–2920–232–34&P	31 December 2005	Direct Support and General Support Maintenance Manual for Fuel Metering and Distributing Pump (Model PSB–12BT) including RPSTL

ITEM	PAGE	PARA	LINE	FIGURE NO.	TABLE	RECOMMENDED CHANGES AND REASON
	0003 00–1					In “INITIAL SETUP” change Torque wrench (6) (item 62, WP 0044 00) to Spanner wrench (item 61, WP 0044 00).

*Reference to line numbers within the paragraph or subparagraph.

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION	SIGNATURE

DA FORM 2028 , FEB 74 REPLACES DA FORM 2028, 1 DEC 68, WHICH WILL BE USED. USAPPC V1.00

SAMPLE

TO: *(Forward direct to addressee listed in publication)*	FROM: *(Activity and location) (Include Zip Code)*	DATE

PART II – REPAIR PARTS AND SPECIAL TOOL LISTS AND SUPPLY CATALOGS/SUPPLY MANUALS

PUBLICATION NUMBER	DATE	TITLE
TM 9–2920–232–34&P	31 December 2005	Direct Support and General Support Maintenance Manual for Fuel Metering and Distributing Pump (Model PSB–12BT) including RPSTL

PAGE NO.	COLM NO.	LINE NO.	NATIONAL STOCK NUMBER	REFERENCE NO.	FIGURE NO.	ITEM NO.	TOTAL NO. OF MAJOR ITEMS SUPPORTED	RECOMMENDED ACTION

PART III – REMARKS *(Any general remarks or recommendations, or suggestions for improvement of publications and blank forms. Additional blank sheets may be used if more space is needed.)*

SAMPLE

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION	SIGNATURE

USAPPC V1.00

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS For use of this form, see AR 25–30; the proponent agency is ODISC4.	Use Part II (*reverse)* for Repair Parts and Special Tools Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).	Date
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ITEM	PAGE	PARA	LINE	FIGURE NO.	TABLE	RECOMMENDED CHANGES AND REASON

**Reference to line numbers within the paragraph or subparagraph.*

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TO: *(Forward direct to addressee listed in publication)*	FROM: *(Activity and location) (Include Zip Code)*	DATE

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TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION	SIGNATURE

By Order of the Secretary of the Army:

PETER J. SCHOOMAKER
General, United States Army
Chief of Staff

Official:

SANDRA R. RILEY
Administrative Assistant to the
Secretary of the Army
0531104

DISTRIBUTION: To be distributed in accordance with the Initial Distribution Number (IDN) 371465, requirements for TM 9-2920-232-34&P.

CONVERSION TABLE

inch	decimal	mm
1/64	0.015625	0.3969
1/32	0.031250	0.7938
3/64	0.046875	1.1906
1/16	0.062500	1.5875
5/64	0.078125	1.9844
3/32	0.093750	2.3812
7/64	0.109375	2.7781
1/8	0.125000	3.1750
9/64	0.140625	3.5719
5/32	0.156250	3.9688
11/64	0.171875	4.3656
3/16	0.187500	4.7625
13/64	0.203125	5.1594
7/32	0.218750	5.5562
15/64	0.234375	5.9531
1/4	0.250000	6.3500
17/64	0.265625	6.7469
9/32	0.281250	7.1438
19/64	0.296875	7.5406
5/16	0.312500	7.9375
21/64	0.328125	8.3344
11/32	0.343750	8.7312

inch	decimal	mm
23/64	0.359375	9.1281
3/8	0.375000	9.5250
25/64	0.390625	9.9219
13/32	0.406250	10.3188
27/64	0.421875	10.7156
7/16	0.437500	11.1125
29/64	0.453125	11.5094
15/32	0.468750	11.9062
31/64	0.484375	12.3031
1/2	0.500000	12.7000
33/64	0.515625	13.0969
17/32	0.531250	13.4938
35/64	0.546875	13.8906
9/16	0.562500	14.2875
37/64	0.578125	14.6844
19/32	0.593750	15.0812
39/64	0.609375	15.4781
5/8	0.625000	15.8750
41/64	0.640625	16.2719
21/32	0.656250	16.6688
43/64	0.671875	17.0656
11/16	0.687500	17.4625

inch	decimal	mm
45/64	0.703125	17.8594
23/32	0.718750	18.2562
47/64	0.734375	18.6531
3/4	0.750000	19.050
49/64	0.765625	19.4469
25/32	0.781250	19.8437
51/64	0.796875	20.2406
13/16	0.812500	20.6375
53/64	0.828125	21.0344
27/32	0.843750	21.4312
55/64	0.859375	21.8281
7/8	0.875000	22.2250
57/64	0.890625	22.6219
29/32	0.906250	23.0188
59/64	0.921875	23.4156
15/16	0.937500	23.8125
61/64	0.953125	24.2094
31/32	0.96750	24.6062
63/64	0.984375	25.0031
1	1.000000	25.4000

THE METRIC SYSTEM AND EQUIVALENTS

LINEAR MEASURE

1 Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 Kilometer = 1000 Meters = 0.621 Miles

WEIGHTS

1 Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 Lb.
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

SQUARE MEASURE

1 Sq. Centimeter = 100 Sq. Millimeters = 0.155 Sq. Inches
1 Sq. Meter = 10,000 Sq. Centimeters = 10.76 Sq. Feet
1 Sq. Kilometer = 1,000 Sq. Meters = 0.386 Sq. Miles

CUBIC MEASURE

1 Cu. Centimeter = 1000 Cu. Millimeters = 0.06 Cu. Inches
1 Cu. Meter = 1,000,000 Cu. Centimeters = 35.31 Cu. Feet

TEMPERATURE

5/9 (°F − 32) = °C
212° Fahrenheit is equivalent to 100° Celsius
90° Fahrenheit is equivalent to 32.2° Celsius
32° Fahrenheit is equivalent to 0° Celsius
(9/5 x °C) + 32 = °F

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Millimeters	29.573
Pints	Liters	0.473
Quarts	Liters	0.946
Gallons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound–Feet	Newton–Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
Liters	Gallons	0.264
Grams	Ounces	0.035
Kilograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton–Meters	Pound–Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
Kilometers per Liter	Miles per Gallon	2.354
Kilometers per Hour	Miles per Hour	0.621