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VEHICLE
RECOMMENDED
PRACTICE**

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Automotive Starter Remanufacturing Procedures

Foreword—This reaffirmed document has been changed only to comply with the new SAE Technical Standards Board Format. Definitions have been changed to Section 3. All other section numbers have changed accordingly.

TABLE OF CONTENTS

1.	Scope	2
2.	References	2
2.1	Applicable Publications.....	2
3.	Definitions.....	2
4.	Remanufacturing Procedure.....	2
5.	Starter Disassembly	3
6.	Frame and Field Assembly	3
7.	Armature Assembly Inspection.....	4
8.	Drive End Housing.....	6
9.	Shift Lever Assembly.....	6
10.	Brushes and Brush Plate/Holder Assemblies.....	7
11.	Starter Drive Assembly.....	8
12.	Gear Reduction/Transmission	8
13.	Solenoid Assembly	9
14.	Starter Reassembly	9

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SAE J2073 Reaffirmed DEC1998

15. Appearance..... 10
16. Testing..... 10
17. Instructions, Packaging, and Safety 11

1. **Scope**—These manufacturing procedures are recommended minimum guidelines for use by remanufacturers of light-duty automotive starters to promote consistent reliability, durability, and safety of remanufactured starters. Installation of remanufactured or rebuilt products is often an economical way to repair a vehicle even though the products may not be identical to original equipment parts. Before processing any part, a remanufacturer should determine if the original design and present condition of the core are suitable for remanufacturing so as to provide durable operation of the part as well as acceptable performance when installed on the vehicle. The remanufacturer should also consider the safety aspects of the product and any recommendations of the original manufacturers related to remanufacturing or rebuilding their product.

While these PROCEDURES are meant to be universal in application, various product types have unique features of dimension and design which may require special remanufacturing processes and tests that are either not covered by or are exceptions to these PROCEDURES.

2. **References**

2.1 **Applicable Publications**—The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

- SAE J2240—Starter Armature Remanufacturing Procedures
- SAE J2241—Automotive Starter Drive Remanufacturing Procedures
- SAE J2242—Automotive Starter Solenoid Remanufacturing Procedures

2.1.2 FEDERAL TRADE COMMISSION REGULATION—Available from Federal Trade Commission, FTC Building, 6th Street and Pennsylvania Avenue, NW, Washington, DC 20580.

Federal Trade Commission Regulation: 16CFR20- 2/27/79 Para 39.051 "Rebuilt, Recon....."

3. **Definitions**

3.1 Drawings shown in this document are intended for illustration only and are not meant to depict any specific unit manufacturer.

4. **Remanufacturing Procedure**—This document provides a procedure for remanufacturing light-duty starters for automobiles and light trucks, similar to the starter shown in Figure 1.

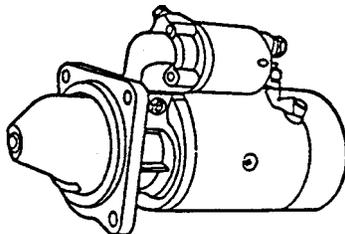


FIGURE 1—STARTER ASSEMBLY

The selection of replacement parts used in the remanufacturing process is critical to the quality, durability, and reliability of the end product. All replacement parts should be carefully evaluated prior to use.

5. **Starter Disassembly**—The starter is to be disassembled into components and subassemblies. Care should be taken to insure that these parts are not damaged by CARELESS handling during the remanufacturing process.

6. **Frame and Field Assembly**

6.1 Field coils and pole pieces may remain installed in the frame if they meet the requirements of this section.

6.2 Clean frame assembly (see Figure 2).

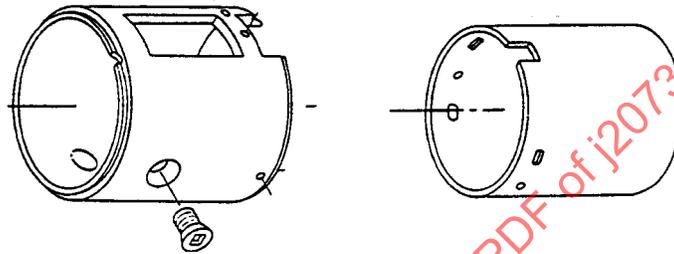


FIGURE 2—FRAME AND FIELD ASSEMBLIES

6.2.1 Inspect for any defects such as distortions or cracks which would affect the functionality of the part. Scrap frames that cannot be restored to an acceptable condition.

6.2.2 Check the inside diameter of all mounting holes. Check the integrity of all other functional holes in the housing. Threaded holes should be visually inspected, gauged, and re-tapped to the same size if necessary. Threads that are not the proper size can be restored by using a thread insert of the same size.

6.3 Clean pole pieces (see Figure 3).

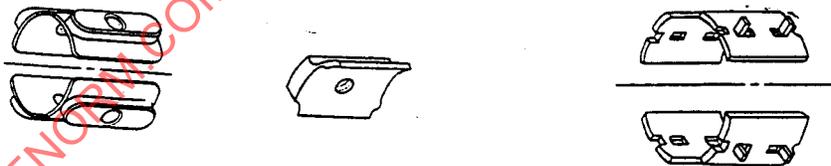


FIGURE 3—POLE PIECES

6.3.1 Inspect for cracks or other defects which may affect the functionality of the part. Replace if necessary.

6.4 Field Coils

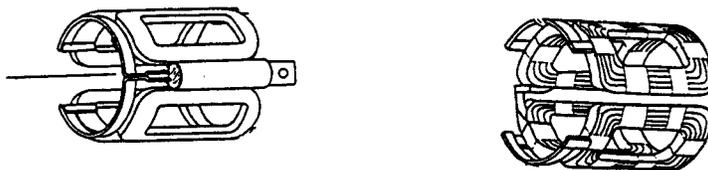


FIGURE 4—FIELD COILS

- 6.4.1 All coils that show visual evidence of overheating are to be replaced as this condition indicates damage to the insulation.
- 6.4.2 Clean the field coil (see Figure 4) with a cleaning agent that will not harm the insulation materials on the coil.
- 6.4.3 Check coil insulation for damage. Repair any damaged areas. The coil should be covered with a good electrical insulation material.
- 6.4.4 Check all field coil terminations for evidence of cracks or overheating. Terminations that exhibit these defects should be replaced.

CAUTION—All solder connections should be made using noncorrosive methods.

- 6.4.5 Test the effectiveness of the insulation on the field coil in the frame assembly by performing a ground test.

6.5 Frame and Magnet Assembly

- 6.5.1 Inspect the field housing for dents.
- 6.5.2 Inspect for loose or cracked magnets. Reattach magnets with clips or with a high strength acrylic magnet bonding adhesive.

7. Armature Assembly Inspection—(See Figure 5.)

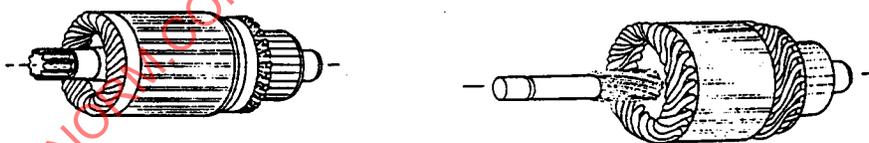


FIGURE 5—ARMATURES

- 7.1 Inspect armature for:
 - 7.1.1 ACCEPTABLE COMMUTATOR OUTSIDE DIAMETER—Runout/Taper—0.076 mm (0.003 in) maximum
 - 7.1.2 BURNED COMMUTATOR BARS—When this open-circuit condition exists, the faulty conductors need to be resoldered or rewelded according to SAE J2240.
 - 7.1.3 GROUND
 - 7.1.3.1 Remove foreign material from armature.

- 7.1.3.2 Check for ground between the commutator bars and the shaft or lamination. If ground exists, the armature must be remanufactured according to SAE J2240 or replaced.
- 7.1.4 SHORT—If a short is detected, clean the armature and retest. If a short still exists, the armature must be remanufactured according to SAE J2240 or replaced.
- 7.1.5 LAMINATION APPEARANCE—An armature may be usable with cosmetic defects (e.g., skewed, staggered, rubbed, or twisted laminations), if it meets all conditions in 7.1.
- 7.1.6 SHAFT STRAIGHTNESS—Bent shafts may be straightened to within 0.076 mm (0.003 in) maximum total indicator reading (TIR). This measurement should be made approximately 6.35 mm (0.250 in) in front of spline.
- 7.1.7 LAMINATION DIMENSIONS—Check for acceptable body outside diameter. Runout should not exceed 0.127 mm (0.005 in) TIR.
- 7.1.8 SPLINES—Visually inspect the armature splines for excessive wear, burns, or imperfections.
- 7.1.9 SHAFT OUTSIDE DIAMETER—Measure this diameter at the bearing areas to determine whether or not there is excessive wear or taper. If there is excessive wear, recondition the shaft and use an appropriate bearing/bushing or replace the shaft.
- 7.1.10 COMMUTATOR BARS—The centerline of the armature wire slots in the lamination stack must be in line with either (a) the center of the commutator bar or (b) the mica between commutator bars, within ± 2 degrees depending on design. This is shown in Figures 6a and b.

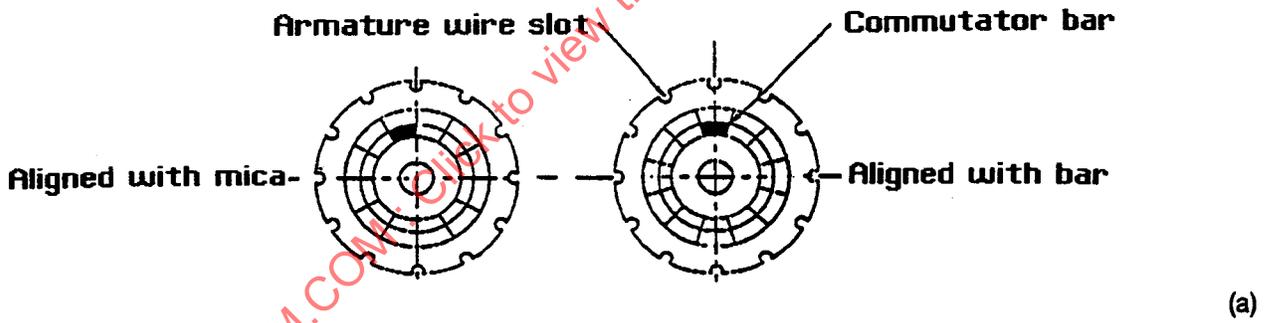


FIGURE 6—COMMUTATOR BAR ALIGNMENT

- 7.1.11 SHAFT POSITION—Check the dimension of commutator and lamination to snap-ring groove or to an appropriate reference point on each armature. (See Figure 7.)

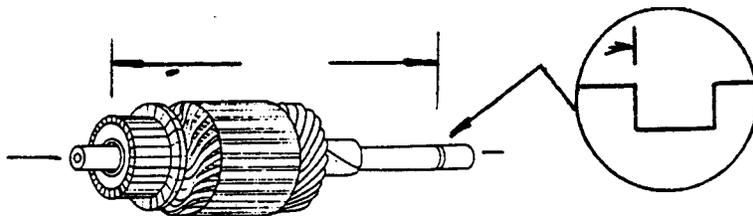


FIGURE 7—DIMENSION: COMMUTATOR TO SNAP-RING GROOVE

7.1.12 SNAP-RING GROOVE—Check for excessive wear.

7.2 Armatures that have loose laminations, loose shaft, or loose wires must be remanufactured according to SAE J2240 or replaced.

8. Drive End Housing

8.1 Clean and inspect the drive housing (see Figure 8) for broken or cracked areas and for a damaged or corroded mounting surface. Scrap broken, cracked, or damaged housings.

NOTE—A cracked housing in a nonstress area can be repaired, depending on the extent and location of the crack or damage.

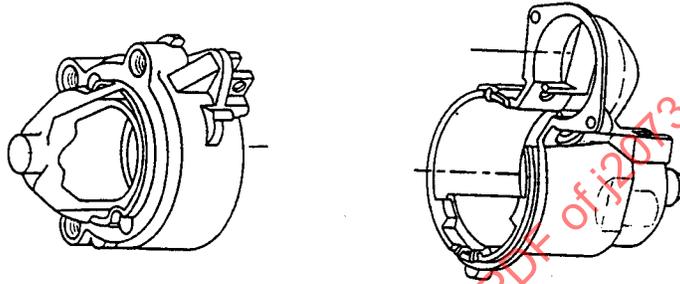


FIGURE 8—DRIVE END HOUSING

8.2 Check the bushing bore inside diameter (ID). If the diameter check shows the hole is oversized, the housing should be scrapped, an oversized bushing should be used or the press fit should be augmented using a high-strength anaerobic retaining compound.

8.3 For mounting hole conditions, refer to 6.2.2.

8.4 Installation of new bushings and bearings is recommended. Design of some motors may not allow practical replacement.

8.5 Gauge all bushings as installed. Bushings can be reused if they are dimensionally correct and relubricated.

8.6 If bearings are reused, inspect for noise and smoothness of rotation and relubricate.

9. Shift Lever Assembly

9.1 Inspect the shift lever (fork) assembly (drive engagement mechanism) for the following (see Figure 9):



FIGURE 9—SHIFT LEVER ASSEMBLY

9.1.1 Hole or pin diameter or condition of threads.

9.1.2 STRAIGHTNESS OF LEVERS—Bent levers can be straightened if not cracked.

9.1.3 SHIFT LEVER BUTTON/FORK WEAR—Replace lever assembly if button wear exceeds 1/8 diameter or 12.5% of original button diameter as shown in Figure 10.

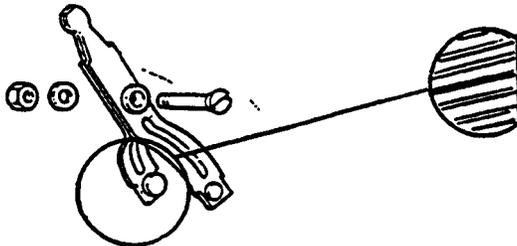


FIGURE 10—SHIFT LEVER BUTTON DIAGRAM

9.1.4 Plunger roll pins should be inspected for tightness.

10. Brushes and Brush Plate/Holder Assemblies

10.1 Clean the brush plate/holder assembly (see Figure 11) to remove contaminants and corrosion.



FIGURE 11—BRUSH PLATE/HOLDER ASSEMBLIES

10.1.1 Protect brush plate/holder assembly from corrosion.

10.2 Inspect brush holder assembly for:

10.2.1 Bent or distorted mounting surface.

10.2.2 Bent or misaligned brush holders.

10.2.3 Cracked or broken brush holder insulators.

10.2.4 Loose brush holders.

10.2.5 Damaged mounting threads.

10.2.6 Grounded brush holders.

10.3 Gauge new bushings and use them as described in 8.4.

10.4 Installation of new brushes is recommended; however, the design of some starters may not allow practical replacement of the brushes only. For starters of this design, brushes may be reused if 80% usable length remains.

10.5 Check brush lead connections. If salvaging existing brushes, solder if needed.

10.6 Install new brush springs or check existing ones for contamination and proper tension. Replace any brush springs which show fatigue, rust, or pitting, etc.

11. Starter Drive Assembly

11.1 Install remanufactured starter drive assembly as described in SAE J2241 or replace with new. (See Figure 12.)



FIGURE 12—STARTER DRIVES

12. Gear Reduction/Transmission

12.1 Transmission Assembly—(See Figure 13.)

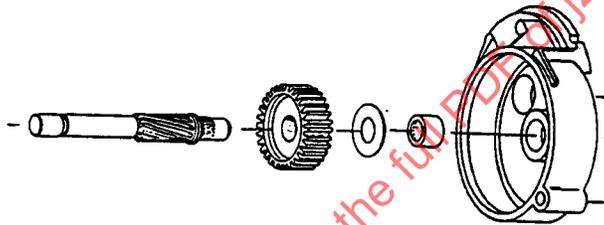


FIGURE 13—GEAR REDUCTION/TRANSMISSIONS

12.1.1 Clean all transmission components.

12.1.2 Inspect gears for wear, chips, or cracks.

12.1.3 Qualify bearings/bushings as per 8.4 and 8.5.

12.1.4 Lubricate all components with a light- or medium-grade silicone lubricant with a temperature range of -32 to 205 °C (-90 to 400 °F).

12.1.5 Install all shims in correct positions.

12.1.6 Check gear movement for proper end-play to prevent binding when cover is installed.

13. Solenoid Assembly

13.1 Inspect the solenoid assembly (see Figure 14) for the following:

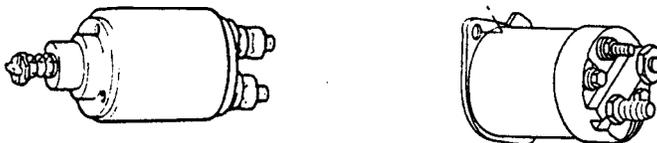


FIGURE 14—SOLENOIDS

13.1.1 Bent or worn contact rod.

13.1.2 Damaged wire terminations.

13.1.3 RESISTANCE OF HOLD-IN AND PULL-IN COILS—Be sure to allow for resistance variations which may result from ambient temperature. If the solenoid does not pass this inspection, remanufacture according to SAE J2242 or replace.

13.1.4 Check for continuity between the coil and the case of the insulated solenoid. If continuity exists, remanufacture according to SAE J2242 or replace.

13.2 Replace the battery terminal if the original terminal cannot be rotated in the cap.

13.3 Replace the cap seal.

13.4 Check contactor in the contact assembly for wear or burned spots. If these conditions exist, the contactor must be replaced. In some cases, these contactors can be turned over or repaired/resurfaced and reused.

14. Starter Reassembly

14.1 Make all soldered/welded connections using a noncorrosive method.

NOTE—Using any corrosive flux such as acid-core solder can cause deterioration of electrical connections and eventual failure of the starter.

14.2 Lubricate the following areas using a non-oxidizing grease with a temperature range of -32 to 205 °C (-90 to 400 °F).

14.2.1 Armature shaft splines, using low-temperature grease.

14.2.2 Shift lever pin.

14.2.3 COMMUTATOR END PLATE BUSHING—Use appropriate grease.

CAUTION—Care must be taken to insure that grease is not allowed to contaminate the commutator area.

14.3 Install the gasket under the plunger cover or brush cover band if it was present in the original equipment motor.

14.4 Reinstall the solenoid heat shield, or hardware, on the starter motor, if a heat shield was present on the original application.