

Heavy-Duty Starter Remanufacturing Procedures

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1. Scope

1.1 These remanufacturing procedures are recommended minimum guidelines (with the understanding that more stringent procedures are acceptable) for use by remanufacturers of heavy-duty starters to promote consistent reliability, durability, and safety of remanufactured starters. Installation of remanufactured or rebuilt products is often an economical way to repair an application 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 application. 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.

1.2 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.

1.3 Rationale—The Service Development Technical Committee requests that this document be re-classified as “Noncurrent”. The reason for the change of designation is that we no longer have any members with expertise to maintain the document.

2. References

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

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

- SAE J544—Electric Starting Motor Test Procedure
- SAE J2240—Starter Armature Remanufacturing Procedures
- SAE J2241—Automotive Starter Drive Assembly Remanufacturing Procedures
- SAE J2242—Automotive Starter Solenoid Remanufacturing Procedures
- Federal Trade Commission Regulations: 16CFR20 - 2/27/79 Para 39.051 "Rebuilt, Recon..."

2.2 Related Publications—The following publications are provided for information purposes only and are not a required part of this document.

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

- SAE J1493—Shielding of Starter System Energization
- SAE J2073—Automotive Starter Remanufacturing Procedures

3. Definitions

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

3.2 Heavy-Duty—Use existing DOT and SAE definitions which refer to class of truck, farm, and industrial vehicles.

- 3.3 **Primary Air Gap**—In a magnetic circuit, primary air gap is defined as an air gap that is designed into the circuit, e.g., pole shoe to armature air gap.
- 3.4 **Secondary Air Gap**—Any undesired air gap that occurs between two parts in the magnetic circuit, e.g., between pole shoes and field cases, caused by paint, rust, machining, grease, etc.
- 3.5 **Ground Test**—This is a test to determine insulation integrity.
- 3.6 **Proper Soldering Techniques**—Make all soldered/welded connections using a noncorrosive method. Using any corrosive flux such as acid-core solder can cause deterioration of electrical connections and eventual failure of the starter.

4. **Remanufacturing Procedure**

- 4.1 This document provides a procedure for remanufacturing heavy-duty starters, similar to the starter shown in Figure 1.

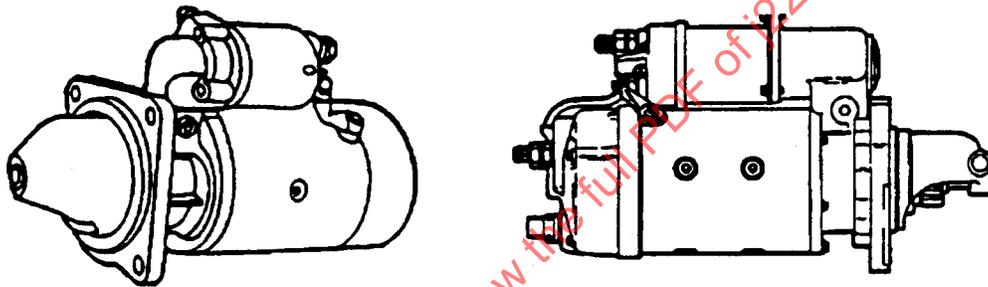


FIGURE 1—STARTER ASSEMBLY

- 4.2 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**

- 5.1 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.
- 5.2 **Frame and Field Assembly**—See Figure 2.

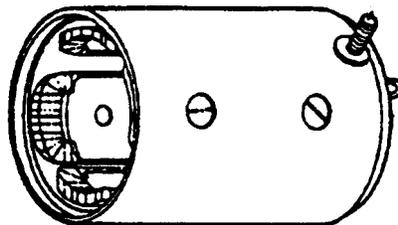


FIGURE 2—FRAME AND FIELD ASSEMBLY

- 5.3 Clean the frame and field assembly or its component parts with a cleaning agent that will not harm the insulation materials on the coils.

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

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

5.4.2 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 retapped 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.

5.4.3 Any condition which may lead to excessive secondary air gap should be corrected.

5.5 Pole Pieces—See Figure 3.

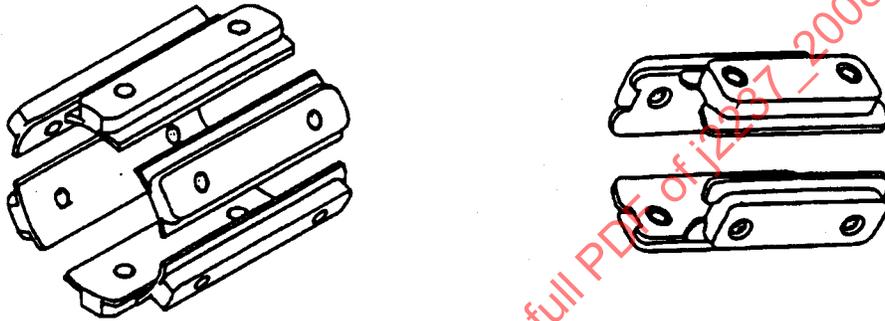


FIGURE 3—POLE PIECES

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

5.5.2 Any condition which may lead to excessive secondary air gap should be corrected.

5.6 Field Coil Assembly—See Figure 4.

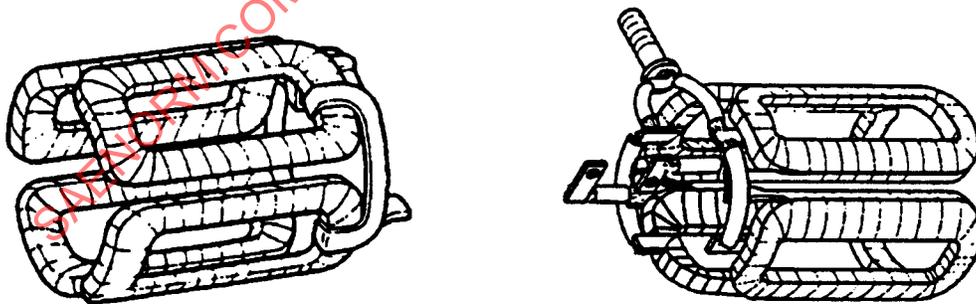


FIGURE 4—FIELD COIL ASSEMBLIES

5.6.1 All coils that show visual evidence of overheating are to be replaced as this condition indicates damage to the insulation.

5.6.2 Clean the field coil assembly with a cleaning agent that will not harm the insulation materials on the coil.

5.6.3 Check coil insulation for damage. Repair any damaged areas with an electrical insulation material.

5.6.4 Check all field coil terminations for evidence of cracks or overheating. Terminations that exhibit these defects should be replaced.

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

5.7 Caution—All welded/soldered connections should be made using noncorrosive methods.

5.8 Frame and Magnet Assembly

5.8.1 Inspect the field housing for dents.

5.8.2 Inspect for loose or cracked magnets. Reattach magnets with clips or with a high-strength acrylic magnet bonding adhesive.

6. Armature Assembly Inspection—See Figure 5.

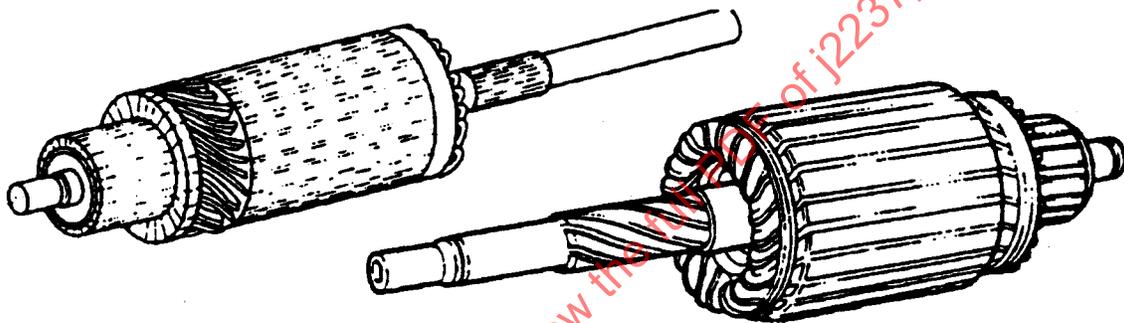


FIGURE 5—ARMATURES

6.1 Check for acceptable commutator outside diameter. Runout/Taper: 0.005 in maximum.

6.2 Burned Commutator Bars—When this open-circuit condition exists, the faulty conductors must be resoldered or rewelded according to SAE J2240.

6.3 Loose Commutator Bars—The armature must be remanufactured according to SAE J2240 or replaced.

6.4 Ground

6.4.1 Remove foreign material from armature.

6.4.2 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.

6.5 Short

6.5.1 If a short is detected, clean the armature, inspect for touching conductors, inspect commutator for bar-to-bar shorts. Touching conductors must be separated and secured. Retest. If a short still exists, the armature must be remanufactured according to SAE J2240 or replaced.

6.6 Lamination

6.6.1 An armature may be usable with cosmetic defects, e.g., skewed, staggered, rubbed, or twisted laminations, if it meets all other conditions in Section 6.

6.6.2 Check for acceptable body outside diameter. Runout should not exceed 0.005 in total indicator reading.

6.7 Shaft

6.7.1 STRAIGHTNESS—Bent shafts may be straightened and maintained to within 0.005 in over the length of the shaft maximum total indicator reading.

6.7.2 SPLINES—Inspect the armature splines for excessive wear, burrs, or imperfections or distortion. If any of these conditions exist, replace shaft according to SAE J2240.

6.7.3 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, replace, or recondition the shaft. Maintain clearance guidelines set in 7.1.

6.7.4 SNAP-RING GROOVE—Check for excessive wear.

6.8 Commutator Bars

6.8.1 ALIGNMENT—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, ± 2 degrees, depending on design. This is shown in Figure 6.

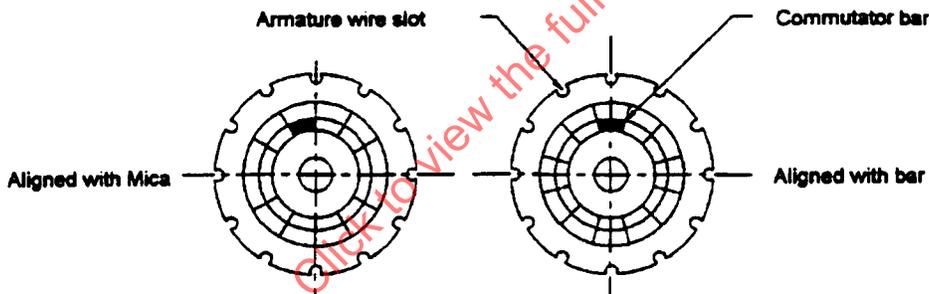


FIGURE 6—COMMUTATOR BAR ALIGNMENT

6.8.2 UNDERCUTTING—Undercut as required by original manufacturer.

6.8.3 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.

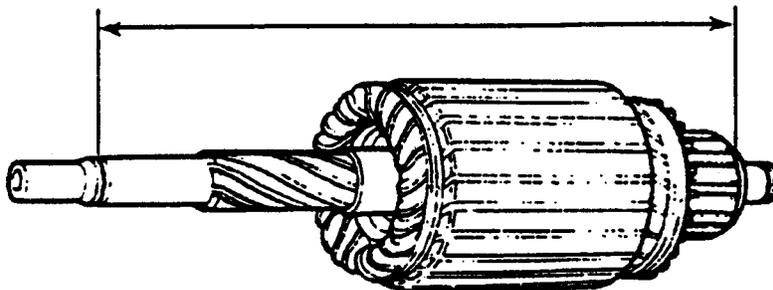


FIGURE 7—DIMENSION: COMMUTATOR TO SNAP-RING GROOVE

6.9 Armatures that have loose laminations, loose shaft, or loose wires, flared windows, rubbed conductors, loose banding, missing insulation must be remanufactured according to SAE J2240 or replaced.

7. Bushings/Bearings

7.1 Bushings

7.1.1 RUNNING SUPPORT—Suggested DE and CE plate clearance for support bushings is 0.0015 to 0.005 in. Shown in Figure 8–8C.

7.1.2 INTERMEDIATE DEFLECTION BUSHING—(Intermediate Plate) Suggested clearance for support bushings is 0.007 to 0.013 in. Shown in Figure 8–8B.

7.1.3 PINION GEAR BUSHINGS—(Drive to Armature Shaft) Suggested clearance for these bushings is 0.003 to 0.005 in. Shown in Figure 8–8A.

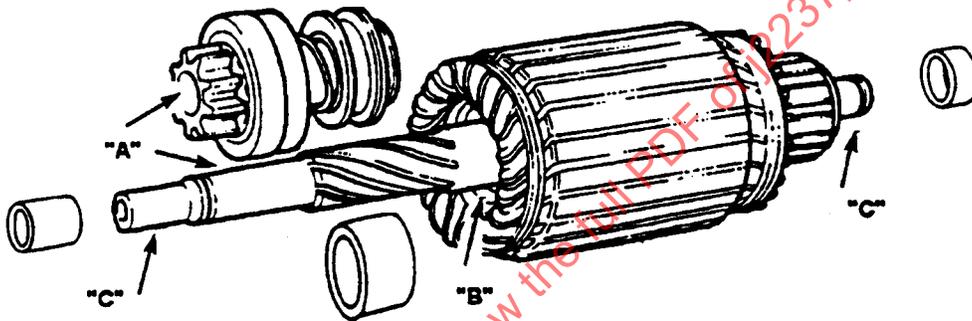


FIGURE 8—ARMATURE BUSHING LOCATIONS A-B-C

7.2 Bearings

7.2.1 Replace bearings with appropriate new bearings per manufacturer's specifications for size and type.

8. Drive End Housing

8.1 Clean and inspect the drive end housing (see Figure 9) for broken or cracked areas and for a damaged or corroded mounting surface. Scrap broken, cracked, or damaged housings. Housing cracked in a nonstress area may be repaired, depending on the extent and location of the crack or damage.

8.2 Remove and discard all felt wicks and clean reservoirs.

8.3 Check the bushing bore inside diameter. If the diameter check shows the hole is oversized, the housing should be scrapped, or an oversized bushing should be used. All bushings shall be retained by a press fit.

8.4 For mounting hole conditions, refer to 5.4.2.

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

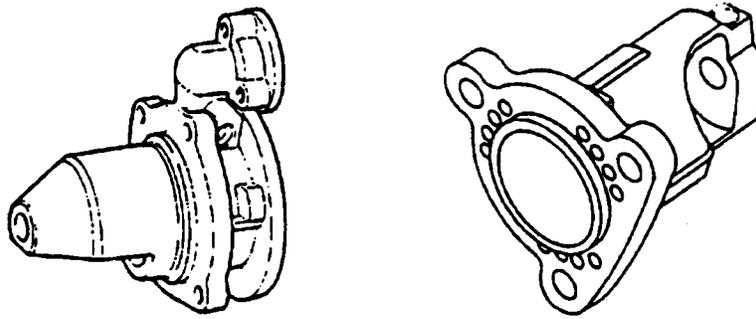


FIGURE 9—DRIVE END HOUSING

8.6 Gauge all bushings as installed.

8.7 Fully saturate all new wicks with the proper lubricating oil. SAE 10 oil is recommended. Install wicks in housing and properly reseal.

9. **Intermediate Center Housing Assembly**

9.1 Clean and inspect the housing (see Figure 10) for broken or cracked areas and for a damaged or corroded mounting surface. Scrap broken, cracked, or damaged housings. Housings cracked in a nonstress area may be repaired, depending on the extent and location of the crack or damage.

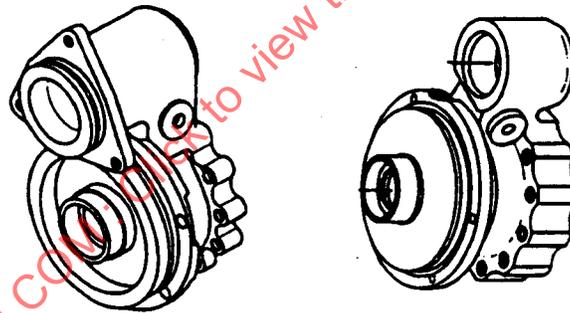


FIGURE 10—INTERMEDIATE CENTER HOUSING ASSEMBLIES

9.2 Remove and discard all felt wicks and clean reservoirs.

9.3 Inspect mounting and shift lever holes for mounting hole conditions, refer to 5.4.2.

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

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

9.6 Fully saturate all new wicks with the proper lubricating oil. SAE 10 oil is recommended. Install wicks in housing and properly reseal.

9.7 Replace all "O" rings, seals, gaskets, and brake washers, where applicable.

10. Shift Lever Assembly

10.1 Inspect the shift lever (fork) assembly (drive engagement mechanism) for the following (see Figure 11):



FIGURE 11—SHIFT LEVER ASSEMBLIES

10.1.1 Pivot holes diameter and/or pin diameter and condition of threads.

10.1.2 Distortion or cracks. Proper alignment is required.

10.1.3 SHIFT LEVER BUTTON/FORK WEAR—Replace lever assembly if button wear exceeds 1/8 of the diameter or 12.5% of original button diameter as shown in Figure 12.

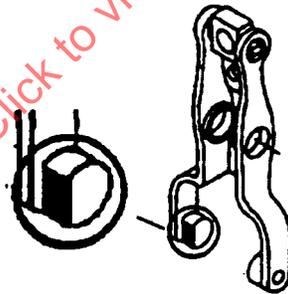


FIGURE 12—SHIFT LEVER BUTTON DIAGRAM

10.1.4 Inspect shift lever pin for wear and insure all grooves/threads are clear and functional.

10.1.5 Replace shift lever pin O-rings where applicable.

11. Brushes and Brush Plate/Holder Assemblies—See Figure 13.

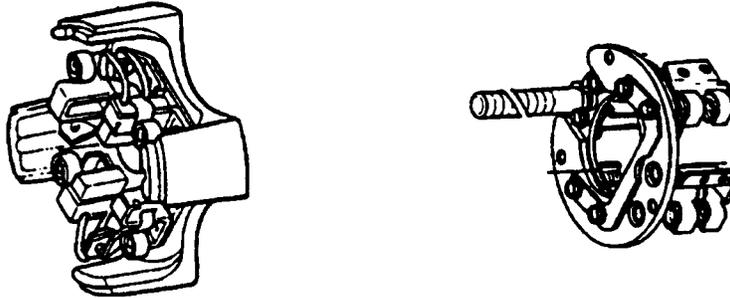


FIGURE 13—BRUSH PLATE/HOLDER ASSEMBLIES

- 11.1** Clean the brush plate/holder assembly to remove contaminants and corrosion. Check insulated brush holders to insure they are not grounded.
- 11.2** Protect brush plate/holder assembly from corrosion.
- 11.3** Inspect brush plate/holder assembly for:
- 11.3.1 Bent or distorted mounting surface.
 - 11.3.2 Bent, misaligned, cracked, worn, or loose brush holders.
 - 11.3.3 Cracked or broken brush holder insulators.
 - 11.3.4 Damaged mounting and connecting threads.
 - 11.3.5 Proper brush to holder clearance with gauge.
- 11.4** Replace bushings as described in 8.4 if applicable.
- 11.5** 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.
- 11.6** Check brush lead connections. When installing brushes, silver solder or weld as required.
- 11.7** Installation of new brush springs is recommended if they show signs of fatigue, rust, pitting, arcing, etc.

12. Starter Drive Assembly—See Figure 14.

12.1 Install remanufactured starter drive assembly as described in SAE J2241 or replace with new.



FIGURE 14—STARTER DRIVES

13. Gear Reduction/Transmission—See Figure 15.

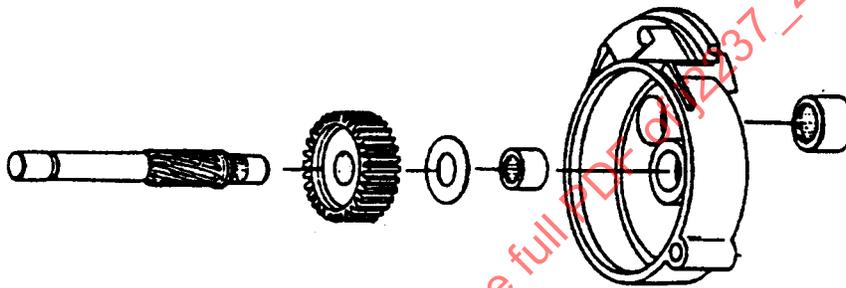


FIGURE 15—GEAR REDUCTION/TRANSMISSION

13.1 Transmission Assembly

13.1.1 Clean all transmission components.

13.1.2 Inspect gears for wear, chips, or cracks.

13.1.3 Qualify bearings/bushings as per 8.4 and 8.5.

13.1.4 Lubricate all components with a light or medium grade silicone lubricant with a temperature range of -90 to 400 °F.

13.1.5 Install all shims in correct positions.

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