# COMPONENT MAINTENANCE MANUAL
# WITH ILLUSTRATED PARTS LIST

# DC STARTER-GENERATOR
# 23291 SERIES

## 23291-005, 23291-006, 23291-007

## ORIGINAL ISSUE: MARCH 09, 2000
## REVISION 10: MARCH 09, 2023

# EXCLUSIVE DISTRIBUTORS

## 1. Contact Information

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# HIGHLIGHTS

TO: Holders of Component Maintenance Manual with IPL for DC Starter-Generator Model 23291 Series.

Attached to this transmittal letter is Revision No. 10 of the Component Maintenance Manual with IPL (original issue dated March 09, 2000).

**REVISION 10, DATED MARCH 09, 2023**

Remove the complete existing manual and replace with this full revision of the manual. Retain the Highlights page(s) in the front of the manual for future reference.

This Component Maintenance Manual has been fully revised to include the latest engineering information and also to include Temporary Revisions, Service Bulletin(s) and Service Information Letter(s) as listed in the Temporary Revisions, Service Bulletin and Service Information List in the front of the manual.

The technical changes in this revision are individually identified with revision bars. The new format of the Safran Power manuals was significantly changed to be more consistent with current standards set by the Air Transport Association of America Specifications ATA-100.

Key items included in this revision:

- Copyright information date changed to 2023.
- Changes done in Introduction section:
  - Updated the overhaul practices.
- Changes done in Testing and Fault Isolation section:
  - Updated the Figure 1002- Equalizing Voltage Acceptance Limits for the models 23080-002, 23080-004 and 23080-058.
- Changes done in Disassembly section:
  - Deleted the Pin Insertion/Extraction Tool.
  - Deleted the procedure to remove pins using pin extraction tool.
- Changes done in Check section:
  - Replaced spline gauge tool (P/N GG98678) with dampener plate gauge tool (P/N 19-601076) to inspect dampener plate.
- Changes done in Assembly section:
  - Deleted the Pin Insertion/Extraction Tool.
  - Added loctite 263 alternative for loctite grade D.
  - To modify the assembly procedures of attaching spacer (370) and 3-pin connector (360) to stator and housing assembly (540).

- Changes done in Fits and Clearances section:
  - Updated the acceptance limits for the internal spline diameter for dampener plate (10001-270).
- Changes done in SPECIAL TOOLS, FIXTURES AND EQUIPMENT section:
  - Incorporated the SIL 23032-1910-24-01 Rev 1 to replace spline gauge tool (P/N GG98678) with dampener plate gauge tool (P/N 19-601076).
- Changes done in ILLUSTRATED PARTS LIST section:
  - Incorporated the TR 24-06 To add caution for the D.E End Bell P/N 23076-1140 for the effect code A.
- The technical and non-technical changes in this revision are individually identified with revision bars.

# RECORD OF REVISIONS

| Revision Number | Date Issued | Date Inserted into CMM | Initials |
|---|---|---|---|
| Original Issue | Mar 09/00 | Mar 09/00 | SP |
| 1 | Sep 22/00 | Sep 22/00 | SP |
| 2 | Oct 17/00 | Oct 17/00 | SP |
| 3 | Jan 04/01 | Jan 04/01 | SP |
| 4 | Jun 30/01 | Jun 30/01 | SP |
| 5 | Jun 01/04 | Jun 01/04 | SP |
| 6 | Feb 18/08 | Feb 18/08 | SP |
| 7 | Oct 22/08 | Oct 22/08 | SP |
| 8 | May 28/13 | May 28/13 | SP |
| 9 | Jan 03/17 | Jan 03/17 | SP |
| 10 | Mar 09/23 | Mar 09/23 | SP |
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# RECORD OF TEMPORARY REVISIONS

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|---|---|---|---|---|---|---|
| 24-01 | various | Nov 08/05 | Nov 08/05 | SP | Feb 18/08 | SP |
| 24-02 | 6024 | Oct 24/12 | Oct 24/12 | SP | May 28/13 | SP |
| 24-03 | 10007 | Dec 23/14 | Dec 23/14 | SP | Jan 03/17 | SP |
| 24-04 | 10014 | Dec 23/14 | Dec 23/14 | SP | Jan 03/17 | SP |
| 24-05 | 10018 | Dec 23/14 | Dec 23/14 | SP | Jan 03/17 | SP |
| 24-06 | 10025 | Mar 16/20 | Mar 16/20 | SP | Mar 09/23 | SP |
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# SERVICE BULLETIN LIST

| Service Bulletin Number | Status | Rev | Date Issued | Service Bulletin Number | Status | Rev | Date Issued |
|---|---|---|---|---|---|---|---|
| 23080-002-24-01 | Superseded | 1 | Apr 29/94 | | | | |
| 23080-002-24-02 | Valid | - | Aug 30/96 | | | | |
| 23080-00X-24-01 | Superseded | 1 | Apr 29/94 | | | | |
| 23080-0XX-24-02 | Superseded | 1 | Apr 29/94 | | | | |
| 23291-XXX-24-01 | Incorporated | 3 | Jan 24/97 | | | | |
| 23291-XXX-24-02 | Incorporated | 4 | Apr 16/97 | | | | |
| 23291-XXX-24-04 | Incorporated | - | May 26/95 | | | | |
| 23291-XXX-24-05 | Incorporated | 1 | Jun 27/97 | | | | |
| 23291-XXX-24-06 | Superseded | 1 | Jul 13/00 | | | | |
| 23291-XXX-24-07 | Incorporated | 4 | Aug 09/00 | | | | |
| 23291-XXX-24-08 | Incorporated | - | Nov 14/02 | | | | |
| 23291-XXX-24-09 | Incorporated | - | Mar 14/03 | | | | |
| 23080-023-24-01FSC | Limited Distribution | 1 | Jun 16/05 | | | | |
| 23080-023B-24-01 | Incorporated | - | Dec 10/04 | | | | |
| 23080-023B-24-02 | Incorporated | 2 | Jun 26/08 | | | | |
| 23291-059-24-01 | Incorporated | - | Dec 10/04 | | | | |
| 23291-059-24-02 | Incorporated | 2 | Jun 27/08 | | | | |
| 23080-360-24-01 | Incorporated | - | Oct 11/05 | | | | |
| 23080-3055-24-01 | Valid | - | May 08/09 | | | | |
| 23080-067-24-01 | Limited | - | Nov 11/08 | | | | |
| 23080-056-24-01 | Limited | - | Nov 01/12 | | | | |
| 23291-006-24-01 | Limited | 2 | May 28/20 | | | | |
| 23291-2060-24-01 | Limited | 0 | Feb 07/13 | | | | |

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# SERVICE INFORMATION LETTER LIST

| Service Information Letter Number | Status | Rev | Date Issued | Service Information Letter Number | Status | Rev | Date Issued |
|---|---|---|---|---|---|---|---|
| 02-5600 | Incorporated | 4 | Jul 07/15 | | | | |
| 03-6010-XX-01 | Incorporated | - | May 02/95 | | | | |
| 23072-1400-01 | Incorporated | 1 | Feb 07/94 | | | | |
| 23075-120X-01 | Superseded | 1 | May 22/90 | | | | |
| 23075-1230-01 | Incorporated | - | Feb 13/92 | | | | |
| 23080-023B-01 | Limited Distribution | - | Jun 12/98 | | | | |
| 23080-3110-01 | Incorporated | - | Mar 15/94 | | | | |
| 23701 | Incorporated | 1 | Jun 19/00 | | | | |
| 23703 | Incorporated | - | Jan 24/97 | | | | |
| 23704 | Cancelled | 1 | Sep 5/08 | | | | |
| GSIL 2006-01 | Incorporated | - | Sep 26/06 | | | | |
| GSIL 2006-02 | Incorporated | 1 | Feb 10/09 | | | | |
| GSIL 2006-03 | Incorporated | - | Sep 15/06 | | | | |
| GSIL 2008-01 | Incorporated | - | Feb 29/08 | | | | |
| GSIL 2011-01 | Incorporated | - | Dec 16/11 | | | | |
| GSIL 2015-01 | Incorporated | - | May 08/15 | | | | |
| SIL 23032-1910-24-01 | Incorporated | 1 | Feb 14/22 | | | | |
| GSIL 2020-01 | Valid | 1 | Apr 16/21 | | | | |
| GIL K4358-24-003 | Valid | 1 | Jan 10/17 | | | | |
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# INTRODUCTION

## 1. Purpose

This Component Maintenance Manual (CMM) provides detailed instructions for overhaul and service repair of the 23291 Series DC Starter-Generators. Line maintenance is supported by Maintenance Manual (MM) 23700. A DC Starter-Generator overhaul includes:

- replacement of non-reusable parts such as bearings, brushes and miscellaneous hardware.
- cleaning of subassemblies.
- detailed inspection of parts, electrical check of all electromagnetic parts (including; insulation integrity check), Non-Destructive Test (NDT) inspections, and complete acceptance testing.

  NOTE: Magnetic particle inspection of the parts as specified in the CHECK section is only required when an overhaul of the generator assembly is being done.

- check of brush holder alignment.
- commutator refinishing and check balance.
- reconditioning of surface finishes as required.
- repair/rework of parts as required.
- re-certification including final assembly, records, and release tags.

Only an overhaul and an acceptance test authorize assignment of zero operating hours time since overhaul (TSO) to a DC Starter-Generator. Repairs performed that are partial of an overhaul do not affect TSO and equipment is released on a continue time basis.

An illustrated parts list is included at the back of this CMM for component identification and ordering of approved replacement parts. The structure and content of this manual is in general accordance with requirements established by the Air Transport Association of America (ATA) for aircraft CMMs. This manual is formatted to conform to ATA Specification No. 100.

Give careful attention to applicable warnings and cautions. Before starting an overhaul procedure, become thoroughly familiar with the capabilities and limitations of the equipment. Make sure all necessary safety equipment, test equipment, repair materials, special tools, and fixtures are on hand.

Model 23291-007 is included newly in this manual. The procedures given in this manual are verified for model 23291-007 by SB 23291-006-24-01 (refer SERVICE BULLETIN LIST).

If an error, omission, or other technical discrepancy is found in this manual, fill out a copy of the Technical Publication Comment Form found at the back of this manual and send to Supervisor of Technical Publications, Safran Power or provide information to Technical Publications e-mail at lps.twn.techpubs@safrangroup.com.

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## 2. User Qualification and Certification Requirements

The information contained in this manual is intended for persons authorized to perform maintenance, preventative maintenance, rebuilding, and alterations in accordance with Federal Aviation Regulation (FAR), Part-43.3.

## 3. Quality Assurance Requirements

The repair stations quality assurance activity is responsible for the correct performance of all tests and inspections specified in this manual. The quality assurance activity will also be responsible for maintaining all necessary test, inspection, and maintenance records for each unit received for service.

All instrumentation and inspection equipment must be calibrated and controlled in accordance with International Standards Organization (ISO) standard 10012, with all standards traceable to the National Bureau of Standards or an equivalent standards regulatory authority.

The quality assurance activity will be responsible for certifying that personnel, skills, and materials meet the requirements of the work to be performed. Components of the DC Starter-Generator undergoing overhaul that are recovered as products of disassembly must be examined 100% to determine serviceability.

The quality assurance activity must maintain documented evidence that specifications applicable to special processes such as soldering, nondestructive testing (NDT), plating, etc. have been complied with during repair and/or overhaul of the DC Starter-Generator.

## 4. Safety Advisory

This manual describes physical and chemical processes that require the use of chemicals or other commercially available materials that require precautionary attention.

The user of this manual should obtain Material Safety Data Sheets and Occupational Safety and Health Act (OSHA) Form 20 or equivalent from the manufacturers or suppliers of materials to be used. The user must become thoroughly familiar with and follow all manufacturer/supplier procedures, recommendations, warnings, and cautions for the safe use, handling, storage, and disposal of materials that require precautionary attention. Users of this manual are also advised to refer to the applicable safety information contained in the “NIOSH Occupational Guideline for Chemical Hazards” published by the United States Department of Labor.

**WARNING:** **ALERTS OPERATING AND MAINTENANCE PERSONNEL TO POTENTIAL HAZARDS THAT COULD RESULT IN PERSONAL INJURY; WARNINGS DO NOT REPLACE THE MANUFACTURER'S RECOMMENDATIONS.**

**CAUTION:** ALERTS OPERATING AND MAINTENANCE PERSONNEL TO CONDITIONS THAT COULD RESULT IN EQUIPMENT DAMAGE.

## 5. Materials List

The materials listed in this section are necessary for processes throughout this manual. A warning and/or caution will precede the use of materials listed in Table i.

**WARNING:** **BEFORE USING ONE OF THE FOLLOWING MATERIALS, BE AWARE OF ALL HANDLING, STORAGE, AND DISPOSAL PRECAUTIONS RECOMMENDED BY THE MANUFACTURER OR SUPPLIER.**

**WARNING:** **FAILURE TO COMPLY WITH MANUFACTURER OR SUPPLIER RECOMMENDATIONS CAN RESULT IN SERIOUS INJURY, PHYSICAL DISORDER, OR DEATH.**

| Material | Used in |
|---|---|
| Acrylic Coating | ASSEMBLY |
| Anti-Seize Compound | ASSEMBLY |
| Chemical Film Solution | REPAIR |
| Corrosion Preventative | CLEANING |
| Detergent | CLEANING |
| Epoxy Bonding Cement | ASSEMBLY |
| Grease | STORAGE |
| Isopropyl Alcohol | ASSEMBLY, CHECK, CLEANING, DISASSEMBLY, REPAIR |
| Loctite Grades A, D | ASSEMBLY |
| Lubricating and Assembly Paste | ASSEMBLY |
| Machine Oil | REPAIR |
| Red Insulating Enamel | ASSEMBLY |
| Silicone Adhesive | ASSEMBLY, REPAIR |
| Thread Sealing Compound | ASSEMBLY |
| Zinc Chromate Primer | REPAIR |
| Zinc Phosphate Coating | REPAIR |

Table i - Material Table

## 6. Non-Safran Power Authorized Components and Processes Policy

Safran Power authorizes the use of Safran Power spare parts which meet stringent engineering design specifications and quality standards, and have traceability to having been procured and certified to design specifications by Safran Power Quality Assurance incoming and in process inspection systems. Other than the type certification holder (airframe manufacturer), Safran Power spares portal is the only authorized distributor of Safran Power replacement parts and complete units.

It is the obligation of all repair and service facilities to provide the FAA, or an other in-country air authority, with proper traceability documentation indicating approval of all spare parts, materials, and processes to make sure configuration compliance and continued air worthiness.

The use of any non-Safran Power authorized part, or any parts not having been submitted to Safran Power Quality Assurance inspection system will invalidate all factory warranties. All Safran Power warranties are automatically voided on a Safran Power designed unit that has been modified by the installation of unauthorized parts, materials, or unapproved processes supplied by other outside services. The repair station's quality assurance activity will assume product liability for all units that have been modified in this fashion.

Damage resulting from the use of non-Safran Power replacement parts, materials, or processes is not covered by the Safran Power warranty or service policy for a product or application.

## 7. Abbreviations

The following abbreviations are used in this manual:

| | |
|---|---|
| ADE | - anti-drive end |
| CMM | - Component Maintenance Manual |
| DE | - drive end |
| GCU | - Generator Control Unit |
| IAW | - in accordance with |
| in. | - inch(es) |
| kPa | - kilopascal(s) |
| lbf.in | - pound force inch |
| µFd | - micro Farad |
| NDT | - Non-Destructive Test |
| N·m | - Newton meter |
| PSIG | - pounds per square inch gage |
| QAD | - Quick Attach/Detach |

| | |
|---|---|
| rms | - root mean square |
| rpm | - Revolutions Per Minute |
| SPD | - Standard Practice Document |
| TIR | - Total Indicator Reading |
| TSO | - time since overhaul |
| UUT | - Unit Under Test |
| Λ | - Ohm |

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# DESCRIPTION AND OPERATION

## 1. Introduction

NOTE: The term “Series IV” does not refer to the equipment covered in this manual. The term “Series IV” distinguishes this manual from other Component Maintenance Manuals covering similar equipment.

The 23291 Series DC Starter-Generator (See Figure 1) operates as a motor to provide torque for engine starting and as a generator to provide DC electrical power after engine starting is complete. Refer to Paragraph 2. of this section for performance and equipment characteristics.

The starter-generator consists of an armature that is enclosed by, and rotates within a stator and housing assembly. The armature is supported by two bearings. At the drive end (DE) of the armature, a bearing is supported by a drive end bearing support assembly. At the anti-drive end (ADE) of the starter-generator, the second bearing is supported by the bearing and brush support assembly. Models covered in this manual incorporate optional bearing preload configuration which improves bearing wear characteristics.

The starter-generator’s drive shaft is installed in the armature shaft which is hollow. The armature shaft and drive shaft have mating splines that engage at the anti-drive end of the starter-generator. At the drive end, a dampener assembly absorbs torsional vibration generated by changes in engine gearbox speed and electrical load conditions. The dampener assembly is made up of a dampener backplate, a friction ring and a dampener plate. Also, at the drive end of the starter-generator is a speed pickup that provides a signal to the generator control unit (GCU) for starter cutoff.

A fan is attached to the anti-drive end of the drive shaft. The fan supplies forced air cooling for on-ground operation. Fins in the bearing and brush support assembly improve cooling by distributing airflow through the generator. In flight, the starter-generator is blast-cooled through the air inlet and the user’s air ducting system in addition to the fan.

Models 23080-059, 23291-006 and 23291-007 have a drive end bearing support assembly which incorporates a tab mounted interface with the quick-attach-detach (QAD) kit. All other models have a drive end bearing support assembly with a flush mount for the QAD interface.

A QAD kit eases starter-generator installation and removal, to and from the aircraft. A QAD kit is comprised of a mounting adapter that attaches to the engine gear box accessory drive pad, and a V-band clamp which secures the starter-generator to the mounting adapter. The 23291 Series DC Starter-Generators and associated parts are listed inthe ILLUSTRATED PARTS LIST section.

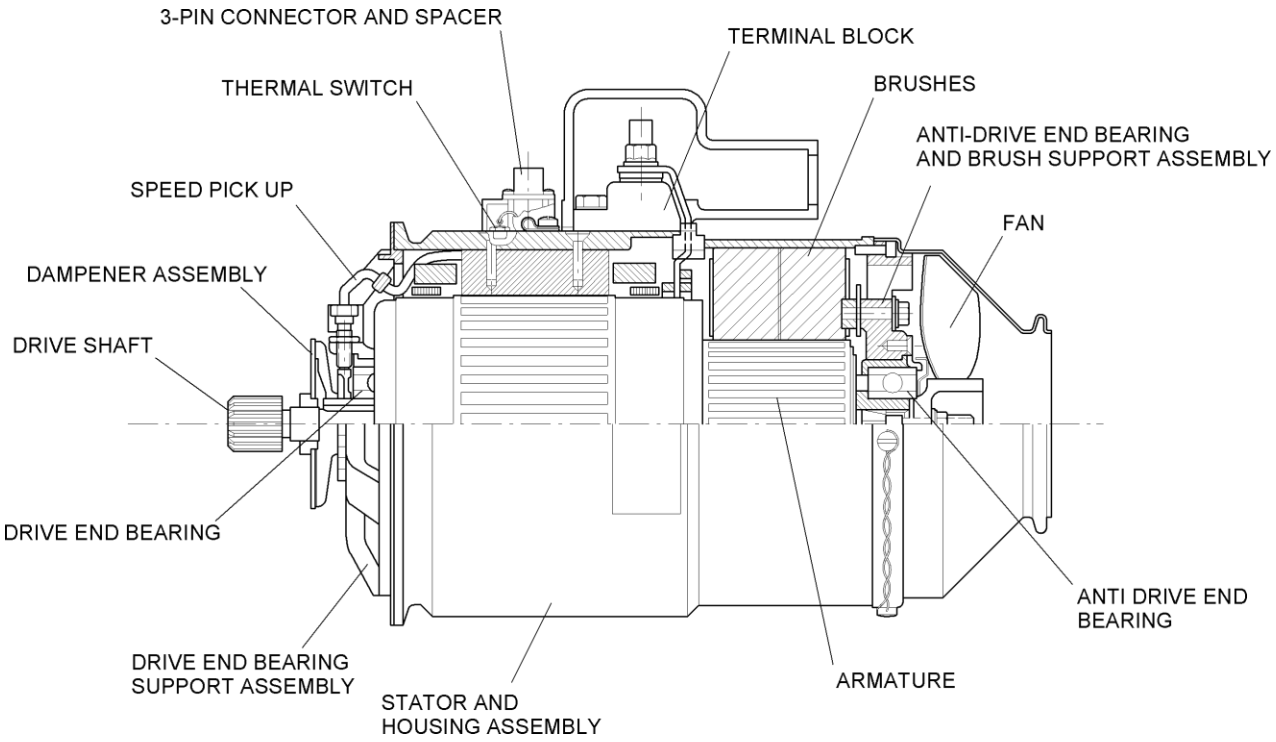



Figure 1 - Typical DC Starter-Generator Features
(Model 23080-023A shown)

## 2. Equipment Specifications.

| Characteristic | Model Number | Specification | |
|---|---|---|---|
| Output rating | All Models | 12 Kilowatts | |
| Rating for continuous load within speed range | 23291-005<br>300 A @ 30 VDC at 7,200 to<br>23291-006<br>12,000 rpm Blast cooled<br>23291-007<br>300 A @ 30 VDC at 7,200 to<br>12,800 rpm Blast cooled | | |
| External starting power supply limitations | 23080-002<br>23080-004<br>23080-023<br>23080-023A<br>23080-023B<br>23080-058<br>23080-059<br>23291-005<br>23291-006<br>23291-007 | Self-limiting current load of 2,000 A max. @ 28 VDC at start receptacle and 0.005 Λ aircraft circuit resistance. | |
| | 23080-056 | Self-limiting current load of 2,000 A max. @ 28 VDC at start receptacle and 0.004 Λ aircraft circuit resistance. | |
| Direction of rotation (viewed from the drive end) | All Models | COUNTERCLOCKWISE | |
| Air inlet opening | All Models | 3.00 inch (76,2 mm) diameter opening | |
| Cooling | All Models | Self-cooled during ground operations. Combination self-cooled and blast-cooled in flight (where applicable). | |
| Terminal designations | All | Shunt Start | Series Start |
| | | B+ Positive<br>E- Negative<br>A+ Shunt Field<br>D Equalizer | B+ Positive<br>E- Negative<br>A+ Shunt Field<br>D Equalizer<br>C+ Starting |

Table 1 - Electrical Performance and Physical Characteristics

| Model Number | Starter-Generator lbs. (kg) | QAD Kit lbs. (kg) | Overhung Moment lbf.in. (N·m) |
|---|---|---|---|
| 23080-001-2 | 38.4 (17,42)* | 1.9 (0,86) | 167 (18,87) |
| 23080-004 | 39.7 (18,01)* | 2.4 (1,09) | 177 (20,00) |
| 23080-023 | 38.3 (17,37)* | 1.8 (0,82) | 185 (20,90) |
| 23080-023A | 38.3 (17,37)* | 1.8 (0,82) | 185 (20,90) |
| 23080-023B | 38.3 (17,37)* | 1.8 (0,82) | 185 (20,90) |
| 23080-056 | 39.7 (18,01)* | 1.4 (0,64) | 190 (21,47) |
| 23080-058 with Air Inlet 23080-1050 | 38.4 (17,42) + | 1.9 (0,86) | 185 (20,90) |
| 23080-058 with Air Inlet 23080-1581 | 39.7 (18,01) + | 2.4 (1,09) | 191 (21,58) |
| 23080-059 | 38.3 (17,37) * | 1.8 (0,82) | 185 (20,90) |
| 23291-005 | 38.3 (17,37)* | 1.8 (0,82) | 185 (20,90) |
| 23291-006 | 38.3 (17,37) * | 1.8 (0,82) | 185 (20,90) |
| 23291-007 | 38.3 (17,37) * | 1.8 (0,82) | 185 (20,90) |
| * With QAD Kit | | + With QAD Kit and Air Inlet | |

Table 2 - Overhung Moment and Weight for DC Starter-Generators

| Model Number | Mounting Flange and Drive Shaft Specification | Drive Shaft | | |
|---|---|---|---|---|
| | | Shear Section: Maximum Torque - lbf.in. (N·m) | Drive Spline Teeth | Pitch Diameter inch (mm) |
| 23080-002<br>23080-004<br>23080-023<br>23080-023A<br>23080-023B<br>23080-058<br>23080-059<br>23291-005<br>23291-006<br>23291-007 | AND10262, Type XII A | 1600 (180,8) | 16 | 0800 (20,32) |
| 23080-056 | MS3331-1P | 1600 (180,8) | 12 | 0.600 (15,24) |

Table 3 - Mounting Flange and Drive Shaft Specifications

## 3. Equipment Improvements and Modifications

23291 Series DC Starter-Generator (See Figure 1) can incorporate one or more modifications. A modification of a particular starter-generator is indicated by a letter in the MOD status box on the identification plate or modification status label. Information regarding modifications of 23291 Series DC Starter-Generators is detailed in various service bulletins listed in the SERVICE BULLETIN LIST at the front of this CMM and also referenced by model number effectivity in the ILLUSTRATED PARTS LIST section of this CMM.

## 4. DC Starter-Generator Operation

Electromagnetic interaction between the armature and stator produces output torque during engine starting and DC electrical power during engine operation.

### A. DC Starter-Generator Operation

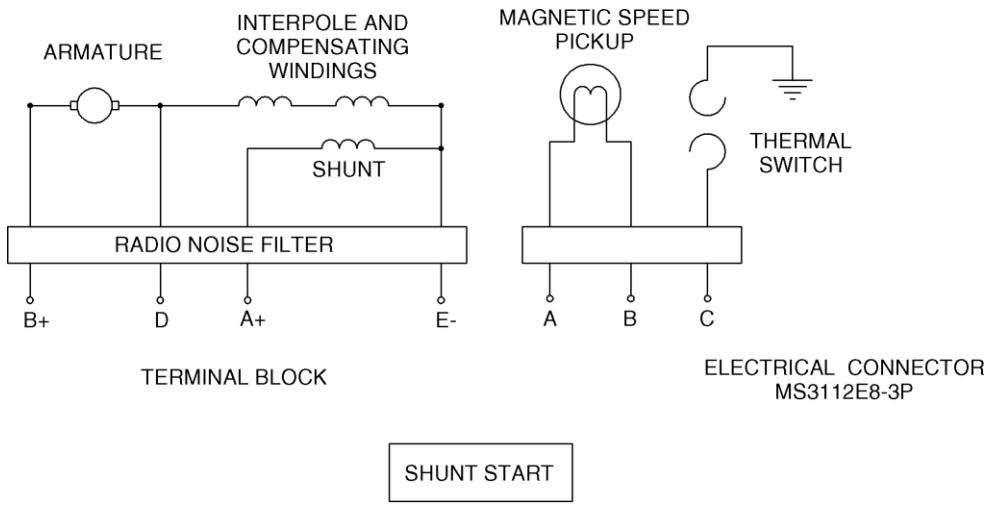
The 23291 Series DC starter-generator operates either as a shunt or series start motor depending on the configuration of the individual unit (see Figure 2 of this section for shunt and series start motor schematics).

#### Shunt Start

During the engine start cycle, the aircraft power bus applies DC voltage across terminals B+ and E-, supplying current to the armature and stator windings. At the same time, a voltage is applied to shunt field terminals A+ and E- from a Generator Control Unit (GCU). Starting power can be supplied by aircraft batteries or a ground power source.

#### Series Start

During the engine start-cycle, the aircraft power bus applies DC voltage across terminals C+ and E-, supplying current to the armature and stator windings. Starting power can be supplied by aircraft batteries or a ground power source.



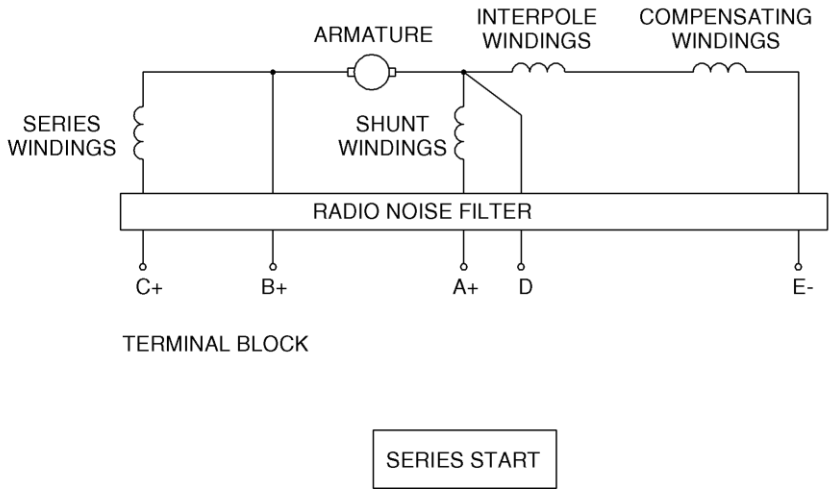




Figure 2 - Shunt and Series Start DC Starter-Generator Motor Schematics

## 5. MOD Status

See Table 4 below for the latest MOD level of each Starter-Generator model:

| 23080- | | | | | | | | 23280- | | | Description |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 002 | 004 | 023 | 023A | 023B | 056 | 058 | 059 | 066 | 067 | 075 | |
| A | - | - | - | - | - | - | - | - | - | - | 03-6010-08 Bearings |
| - | - | A | - | - | - | - | - | - | - | - | 03-6010-14 Bearings |
| B | A | - | - | - | - | - | - | - | - | - | 03-6010-15 Bearings |
| C | B | B | - | - | - | A | - | - | - | - | 03-6010-18 Bearings |
| D | C | E | - | - | - | B | - | - | - | - | 23080-370 Armature |
| E | D | D | - | - | - | C | - | - | - | - | 23080-1903 Brushes |
| F | E | G | - | - | - | D | - | - | - | - | 23076-339 Stator and Housing |
| G | F | F | - | - | - | E | - | - | - | - | 23080-1348 Drive End Bearing Support Assembly |
| H | G | C | - | - | - | F | - | - | - | - | 23080-360 Bearing and Brush Support Assembly |
| J | H | H | A | A | - | G | - | - | - | - | 23080-381 Drive End Bearing Support Assembly (Pre-Load) |
| - | - | J | C | B | - | - | A | - | - | - | 23080-3111/3112 Bearing Shields, 23065-1747 Fan |
| - | - | - | - | - | A | - | - | - | - | - | 23080-383 Drive End Bearing Support Assembly (Pre-Load) |
| - | - | - | - | C | - | - | B | - | - | - | Testing re-specified |

Table 4 - MOD Status

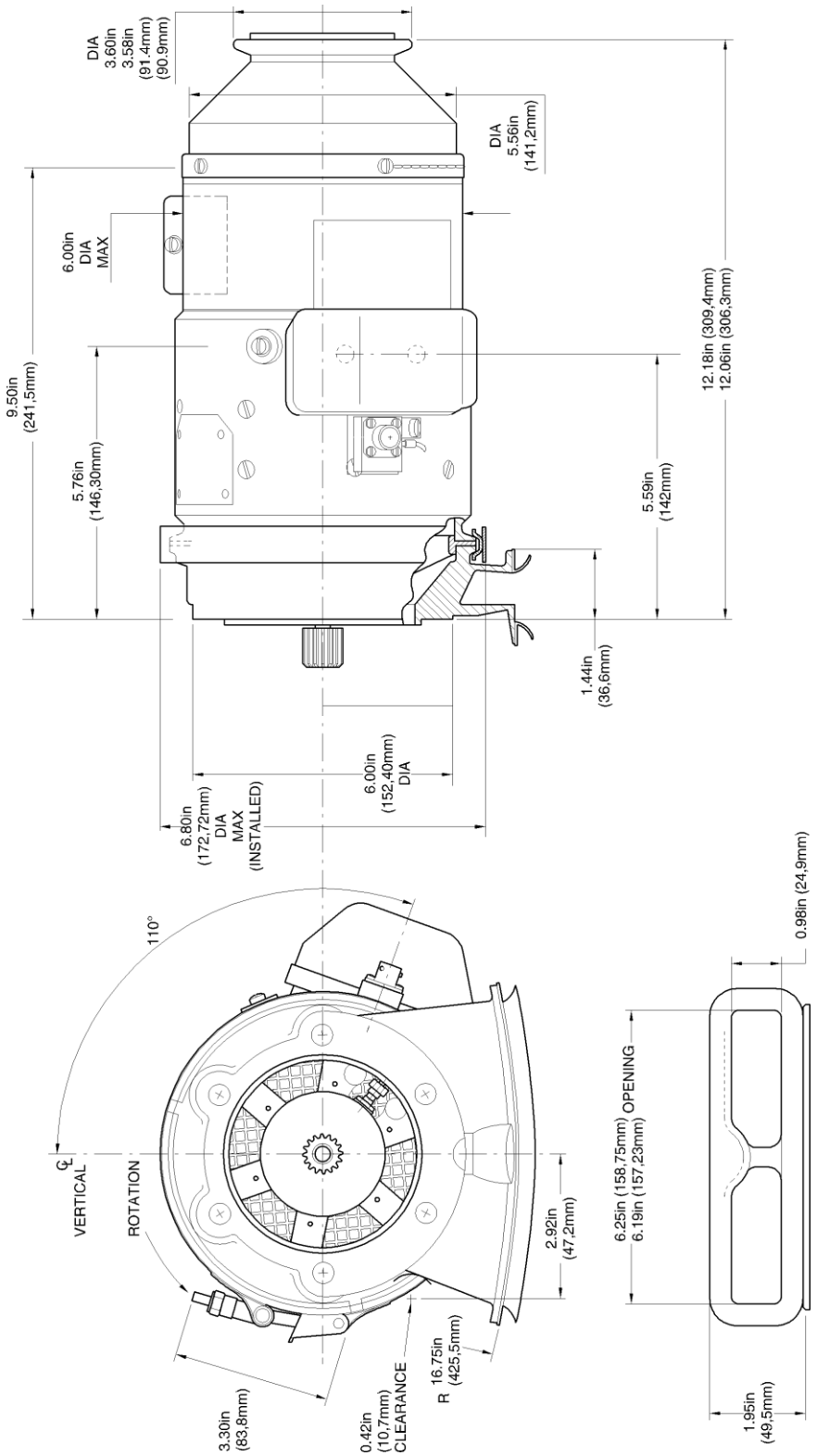



Figure 3 - Models 23080-002 and -058 DC Starter-Generator Outline Diagram

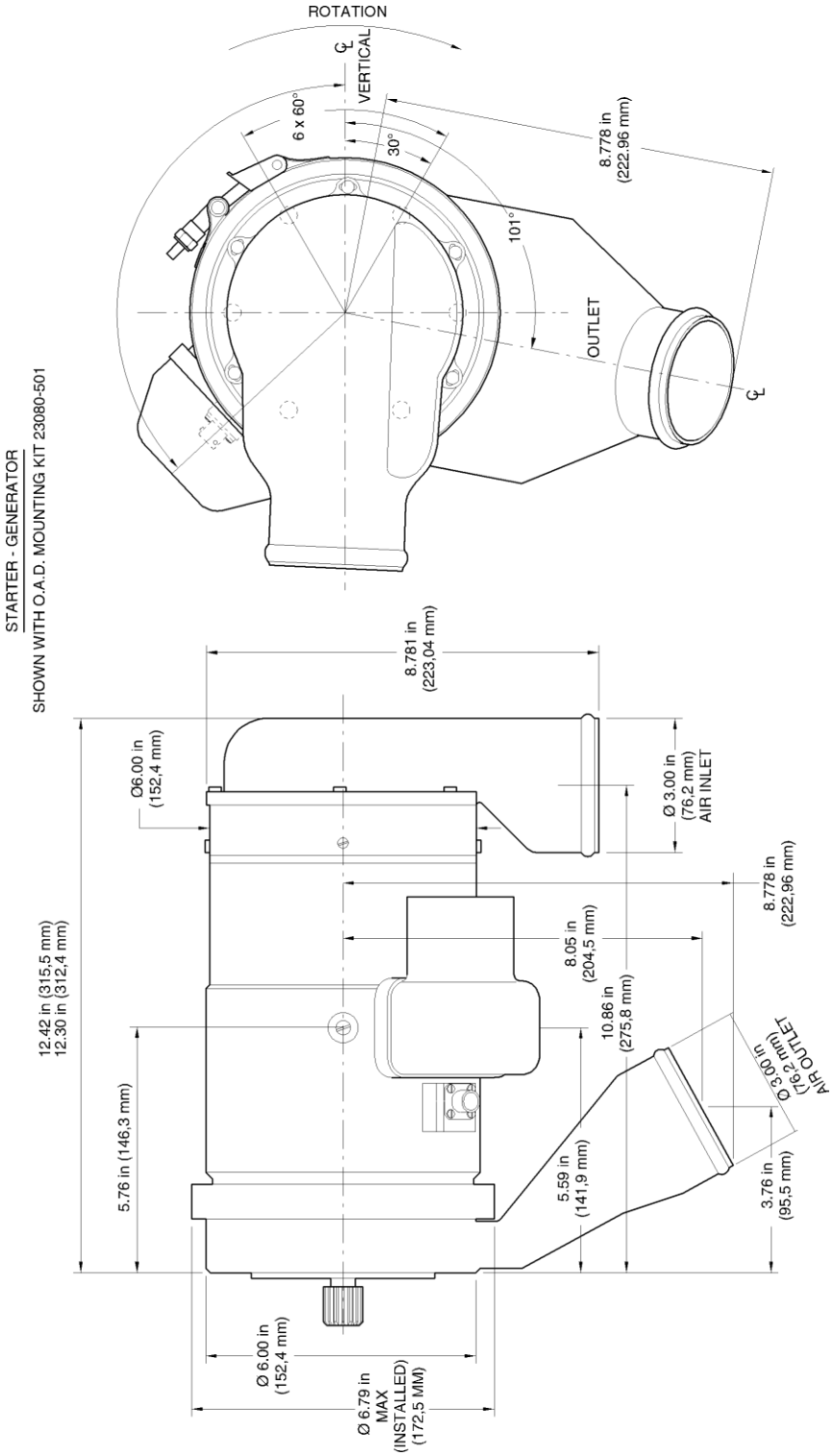



Figure 4 - Model 23080-004 DC Starter-Generator Outline Diagram

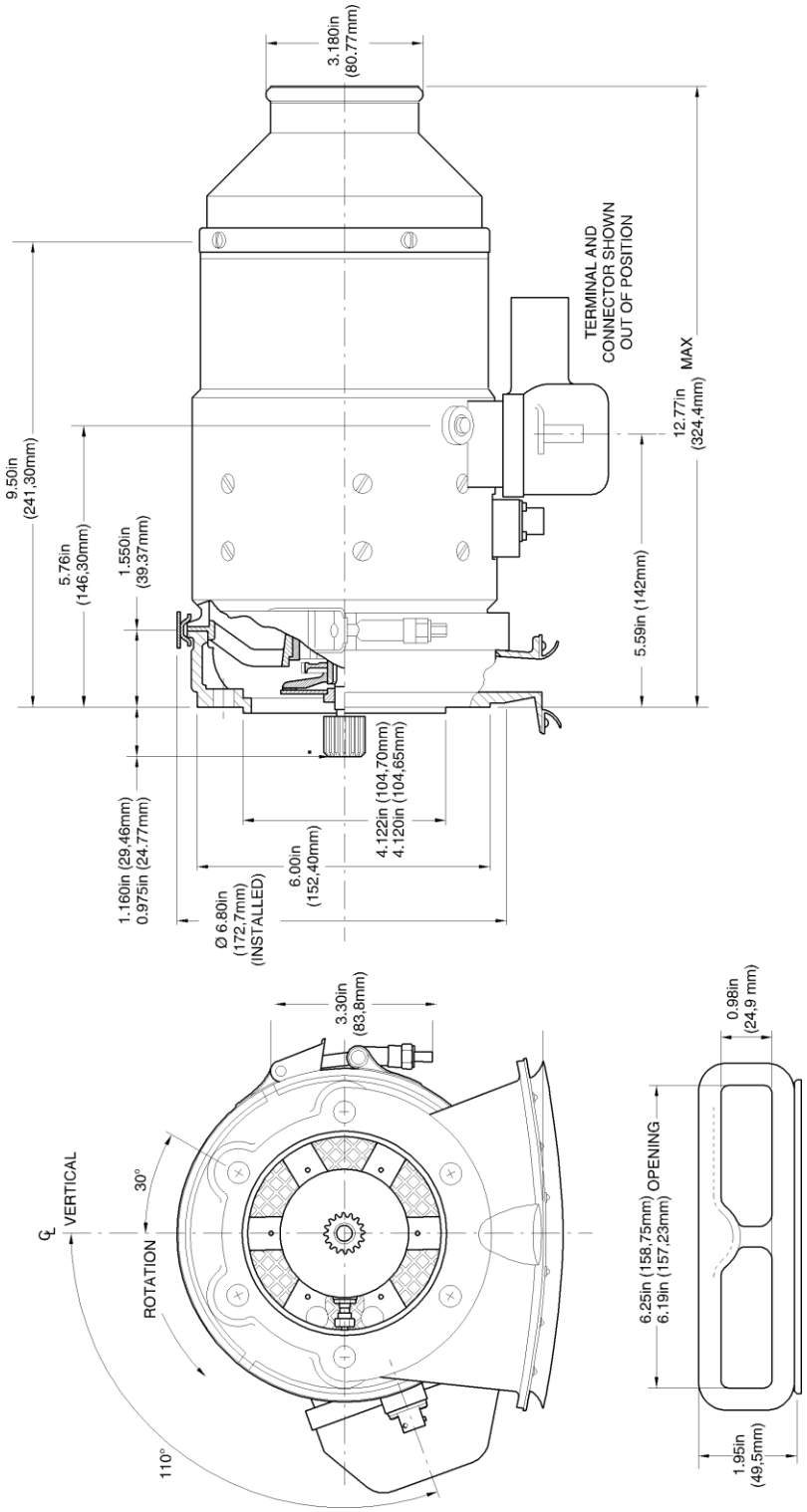



Figure 5 - Models 23080-023, 23080-023A, 23080-023B, 23080-059, 23291-005, 23291-006 and 23291-007 DC Starter-Generator Outline Diagram

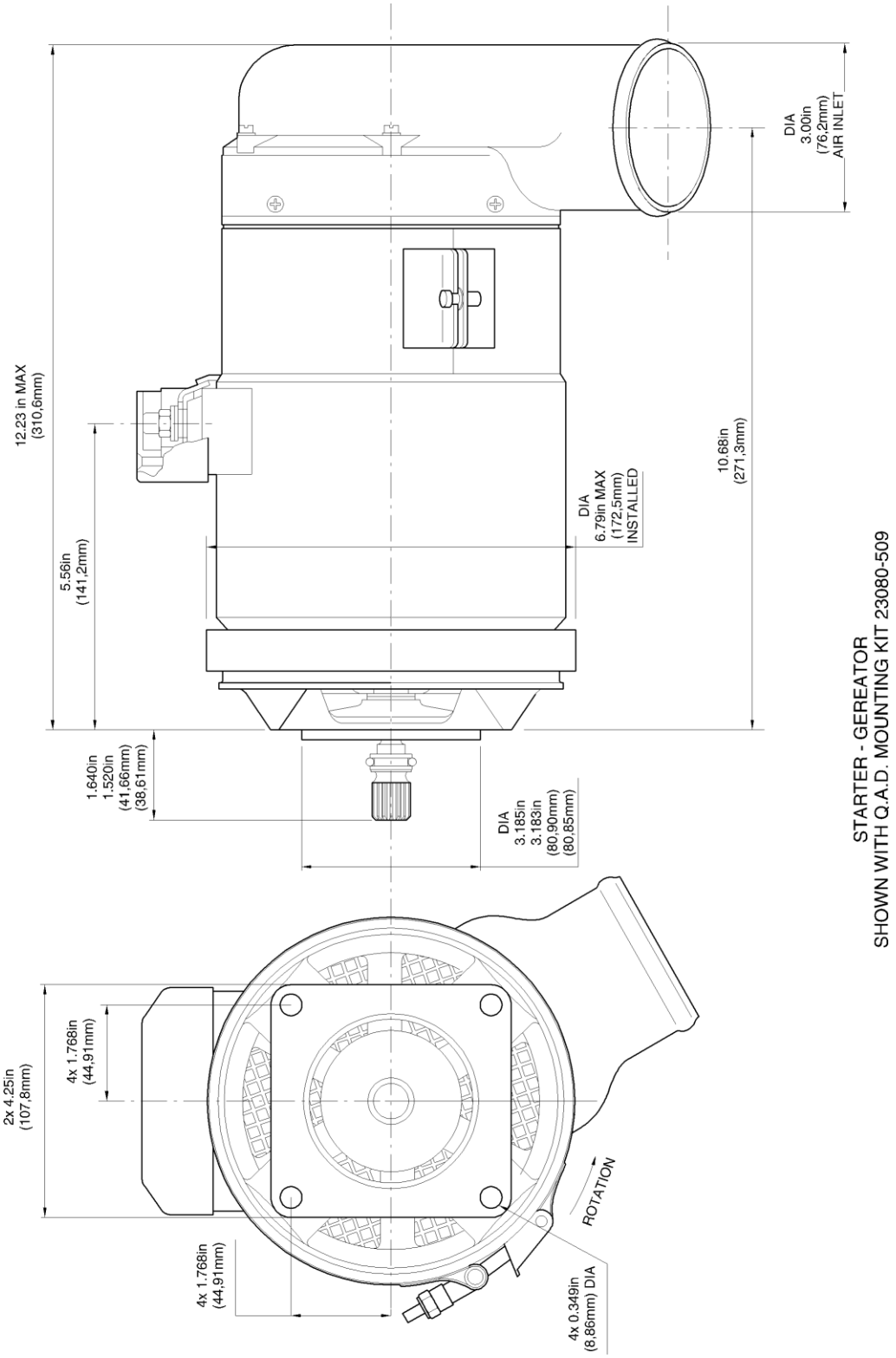



Figure 6 - Model 23080-056 DC Starter-Generator Outline Diagram

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# TESTING AND FAULT ISOLATION

## 1. Introduction

**WARNING: THE DC STARTER-GENERATOR CAN PRODUCE HIGH OUTPUT CURRENT CAPABLE OF CAUSING SEVERE SHOCK OR DEATH. MAKE SURE ALL POWER IS SHUT OFF TO GENERATOR BEFORE REMOVING OR REPLACING TEST EQUIPMENT, INSTRUMENTS, OR ASSEMBLIES. TAKE EXTREME CARE WHEN PERFORMING "LIVE CIRCUIT" TESTS AND FAULT ISOLATION PROCEDURES.**

The procedures provided in this section are performance tests and are classified as either verification tests or acceptance tests. A verification test is conducted to assist in fault isolation or to confirm the cause for removal before the repair or overhaul of the DC Starter-Generator. An acceptance test is conducted after the repair or overhaul of the unit. Record all test results on a photocopy of the data sheet(s) provided at the end of this section.

**Verification Testing:** A starter-generator requiring confirmation of the cause for removal or qualification for continued service must be inspected as detailed in Paragraph 3. of the CHECK section before testing can begin. A unit that passes initial inspections can be tested in accordance with this section to determine performance or to isolate a particular fault. When a fault is identified during testing, refer to the fault isolation tables in this section to determine the probable cause.

**Acceptance Testing:** A unit that has been overhauled or repaired and is ready to be returned to service must be tested in accordance with this section to verify minimum performance standards. Only when an acceptance test is fully completed, and in the order presented in this section, can zero operating hours time since overhaul (TSO) be assigned to an overhauled unit.

## 2. Test Conditions

Refer to Table 1001 for a list of performance test conditions. Unless otherwise specified, all of the parameters in Table 1001 apply to a test..

| Parameter | Operating Condition |
|---|---|
| Ambient Temperature | 77° ± 27°F (25° ± 15°C) |
| Barometric Pressure | Ambient pressure, 30 ± 3 in. (762 ± 76 mm) of mercury, at sea level up to 1,500 ft (457,2 m). |
| Brush Seating Procedures | Refer to Safran Power Standard Practice Document (SPD) 1006 for brush installation, seating, and run-in procedures. |

Table 1001 - Performance Test Conditions

| Parameter | Operating Condition |
|---|---|
| Forced Cooling Air | A total air pressure equal to 6 inch (15 cm) $H_2O$, measured 12 inch (30.5 cm) upstream of starter-generator air inlet. |
| | Cooling air is supplied through a straight air inlet duct 3 inch dia. x 36 inch long (7,6 cm dia. x 91,4 cm long). |
| Physical Mounting | Drive shaft must be in horizontal position. |

Table 1001 - Performance Test Conditions

## 3. Test Equipment

Refer to Table 1002 for a list of special tools, fixtures, and equipment needed for testing and fault isolation. Equivalent substitutes can be used for items listed.

NOTE: Airflow meters and pressure gauges used in the testing of this unit should be certified and calibrated in accordance with ISO10012-1 or should have current calibration traceable to a National Bureau of Standards (NBS) standard. If properly calibrated equipment is not available, the Unit Under Test (UUT) should be sent to an authorized Safran Power repair facility for all the procedures in this manual.

| Equipment | Range and Accuracy or Equipment Rating | Ref. Des. |
|---|---|---|
| Commutation Viewing Adapter | SPECIAL TOOLS, FIXTURES, AND EQUIPMENT section | (Figure 9003) |
| DC Ammeter | Range: 0 to10 A<br>Accuracy: ± 1% of reading | $A_1$ |
| DC Variable Power Supply | Range: 0 to 30 VDC | Power Supply |
| DC Voltage Regulator | Range: 0 to 30 VDC | Voltage Regulator |
| DC Voltmeter | Range: 0 to 50 VDC<br>Accuracy: ± 1% of reading | $V_2$ |
| DC Voltmeter (Generator) | Range: 0 to 50 mVDC<br>Accuracy: ± 1% of reading. | $V_1$ |
| DC Voltmeter (Starter) | Range: 0 to100 mVDC<br>Accuracy: ± 1% of reading. | $V_1$ |
| DC Voltmeter (2 req'd) | Range: 0 to 10 VDC<br>Accuracy: ± 1% of reading | $V_3$,$V_4$ |
| Generator Drive Stand | Range: 4,000 to 20,000 rpm<br>Accuracy: ± 5 rpm of reading | Not illustrated |
| Generator Load Switch | Rating: 30 VDC, 500 A | $SW_1$ |

Table 1002 - Test Equipment

| | | |
|---|---|---|
| High Potential Tester | Rating: 250 VAC RMS, commercial frequency | Not illustrated |
| Manometer | Range: 0 to 10 inch (0 to 254 mm) $H_2O$<br>Accuracy: ± 5% of reading | Not illustrated |
| Oscilloscope | Digital: Band width of 100 MHz Sampling rate of 100 MS/s<br>Analog: Bandwidth of 60 to 100 MHz | Not illustrated |
| Precision Shunt (Generator) | Rating: 500 A; 50 mVDC | $SH_1$ |
| Precision Shunt (Starter) | Rating: 1000 A; 100 mVDC | $SH_1$ |
| Shunt Field Switch | Rating: 30 VDC, 10 A | $SW_3$ |
| Dummy Terminal Block | A dummy terminal block may be used during testing to avoid damage to filter capacitors. | Not illustrated |
| Thermometer (or other temperature measuring device) | Range: 32° to 260° F (0° to 127° C)<br>Accuracy: ± 1° F (0.5° C) | Not illustrated |
| Variable Load Bank | Rating: 30 VDC, 0 to 400 A | Variable Load Bank |
| Voltage Regulator Switch | Rating: 30 VDC, 10 A | $SW_2$ |

Table 1002 - Test Equipment (Continued)

## 4. Generator Thermal Stabilization

Stabilization is reached when either of the following conditions is met:

- Temperature of shunt field winding (A-E), as determined by its resistance, rises no more than 2° F (1.1° C) in five minutes.
- Frame temperature measured on side opposite terminal block, does not rise more than 2° F (1.1° C) in five minutes.

## 5. Test Condition Setpoint Tolerances

Test condition setpoint must be set within tolerances indicated in Table 1003, exclusive of measurement accuracy.

| Parameter | Test Condition Setpoint Tolerance |
|---|---|
| Speed (rpm) | ± 20 rpm |
| DC Voltage | ± 0.1 VDC |
| DC Current | ± 2.5 A |
| Cooling Air Pressure | ± 0.2 inch (5,1 mm) - water |
| Torque | ± 1.0 lbf.ft (± 1,37 N·m) |

Table 1003 - Setpoint Tolerances

## 6. Test Setup

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10001 of ILLUSTRATED PARTS LIST.

### A. Perform initial inspection.

(1) Examine starter-generator in a brightly lit work area. Refer to procedures in CHECK section. Inspection results determine whether disassembly and repair are required before testing.

### B. Check brush seating.

NOTE: In a starter-generator being prepared for verification testing, installed brushes may or may not require brush seating.

**CAUTION:** THE STARTER-GENERATOR MUST BE SUPPORTED AT ALL TIMES DURING INSTALLATION AND REMOVAL. DO NOT ALLOW THE UNIT TO HANG UNSUPPORTED. EXCESSIVE BENDING LOADS ON THE DRIVE SHAFT CAN DAMAGE THE SHEAR SECTION.

(1) Make sure all brushes (190) are correctly seated according to procedures in SPD 1006.

### C. Clean the starter-generator.

NOTE: Make sure that starter-generator is clean before proceeding with Acceptance Testing.

(1) Refer to CLEANING section for details.

**D. Attach dummy terminal block to starter generator or isolate terminal block grounding lead.**

**CAUTION:** THE STARTER-GENERATOR MUST BE SUPPORTED AT ALL TIMES DURING INSTALLATION AND REMOVAL. DO NOT ALLOW THE UNIT TO HANG UNSUPPORTED. EXCESSIVE BENDING LOADS ON THE DRIVE SHAFT CAN DAMAGE THE SHEAR SECTION.

**CAUTION:** ACCEPTANCE TESTING CAN DAMAGE FILTER CAPACITORS INSIDE UNITS TERMINAL BLOCK.

(1) Refer to DISASSEMBLY section and ASSEMBLY section for details.

NOTE: If the grounding lead is removed, make sure to cover the lead with electrical tape before doing a dielectric test.

NOTE: Terminal block 23079-1040 has the lead grounded by the terminal block mounting screw (10004-90). The lead is located between terminals B and D. By removing the single mounting screw, the grounding lead will be isolated.

**E. Install commutation viewing adapter.**

(1) Remove brush access cover (160). Refer to DISASSEMBLY section for details.

**WARNING: DURING OPERATION, THE DC STARTER-GENERATOR CAN PRODUCE A HIGH OUTPUT CURRENT CAPABLE OF CAUSING SEVERE SHOCK OR DEATH. MAKE SURE ALL POWER IS OFF TO STARTER-GENERATOR BEFORE REMOVING OR REPLACING TEST EQUIPMENT, INSTRUMENTS, OR ASSEMBLIES. TAKE EXTREME CARE WHEN PERFORMING "LIVE CIRCUIT" TESTS AND FAULT ISOLATION PROCEDURES.**

**CAUTION:** STARTER-GENERATOR MUST BE SUPPORTED AT ALL TIMES DURING INSTALLATION OR REMOVAL. DO NOT ALLOW UNIT TO HANG UNSUPPORTED. TOO MUCH BENDING LOAD ON DRIVE SHAFT CAN DAMAGE SHEAR SECTION.

(2) Put commutation viewing adapter on stator and housing assembly (540).

**CAUTION:** DO NOT CENTER BRACKETS DIRECTLY OVER AN OPENING IN STATOR AND HOUSING ASSEMBLY.

(3) Center brackets of commutation viewing adapter over one rib of stator and housing assembly (540).

(4) Insert screw into blind rivet nut on bracket of commutation viewing adapter and tighten screw to a torque of 25 to 35 lbf.in. (2,8 to 4,0 N·m).

**F. Install starter-generator on test stand.**

NOTE: The starter-generator mounts to the mounting adapter (part of the QAD kit) that is attached to the drive stand.

NOTE: The 23291 Series starter-generators included in this CMM are not supplied with a QAD kit. QAD kits must be ordered separately and used during acceptance testing. Refer to the ILLUSTRATED PARTS LIST Figure 10005 for QAD kit part numbers.

**CAUTION:** THE STARTER-GENERATOR MUST BE SUPPORTED AT ALL TIMES DURING INSTALLATION OR REMOVAL. DO NOT ALLOW UNIT TO HANG UNSUPPORTED. TOO MUCH BENDING LOAD ON DRIVE SHAFT CAN DAMAGE SHEAR SECTION.

(1) Install mounting adapter on drive stand.

(2) While supporting anti-drive end of starter-generator, align and install drive end to mounting adapter plate.

(3) Make sure that drive stand and starter-generator mating splines are properly engaged.

(4) Install V-retainer coupling (10005-10) on mounting adapter and starter-generator. To secure, tighten nut to a torque of 70 lbf.in. (7,9 N·m).

**G. Connect starter-generator to electrical test circuit.**

(1) Turn all power OFF at drive stand.

(2) Connect generator to test circuit. See Figure 1001 for details.

(3) Assemble terminal block hardware to terminal block. Refer to ASSEMBLY section for details.

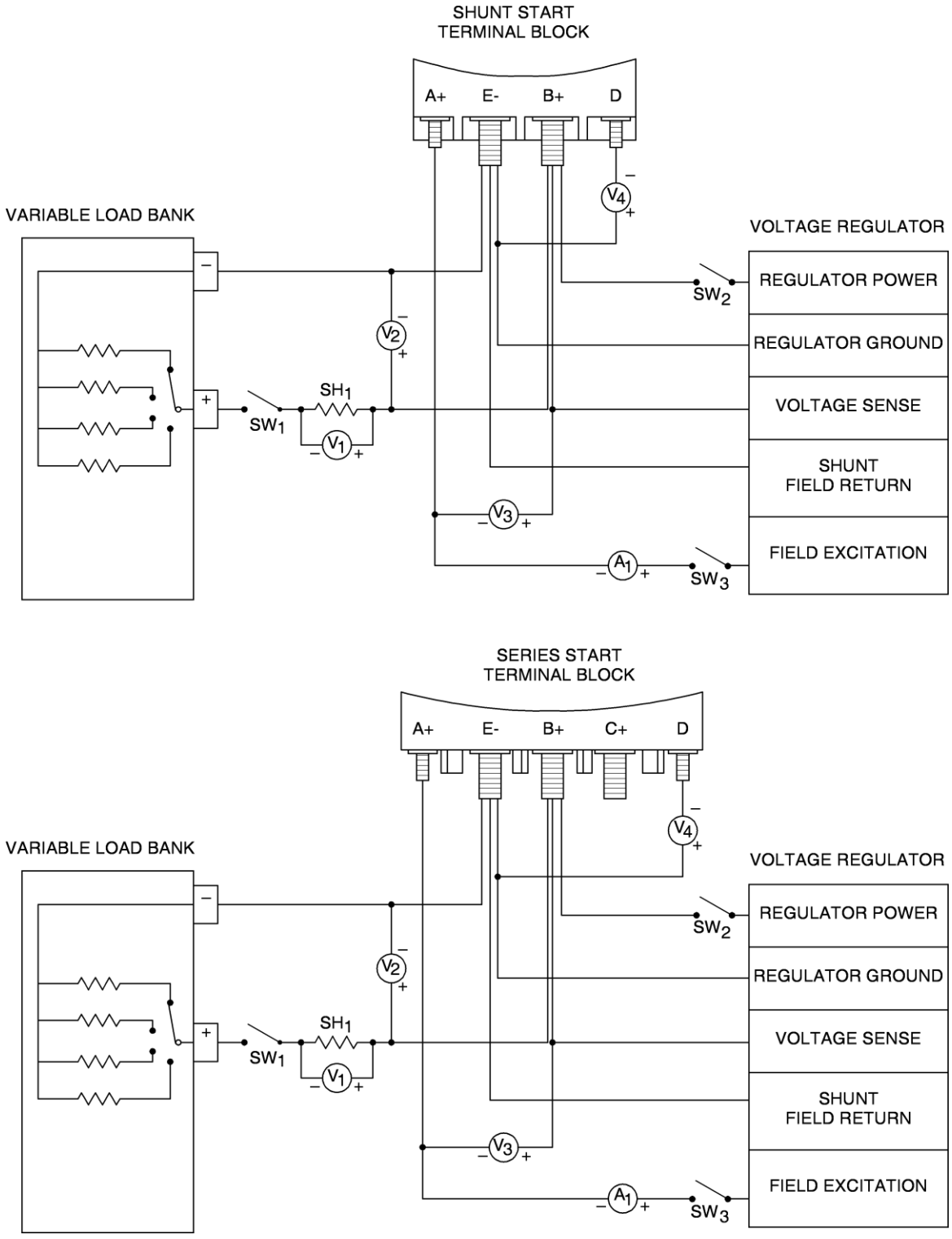


Figure 1001 - DC Starter-Generator Test Connection Diagram (Shunt and Series Start)

## 7. Test Procedures

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10001 of ILLUSTRATED PARTS LIST.

**CAUTION:** IF AN ACCEPTANCE LIMIT IS EXCEEDED BY EVEN A SMALL MARGIN, DO NOT CONTINUE FURTHER TESTING OF STARTER-GENERATOR. BE AWARE THAT TESTING OF A DC STARTER-GENERATOR BY ANY LIMIT AFTER IT HAS EXCEEDED THAT LIMIT CAN DAMAGE THE STARTER-GENERATOR.

Tests must be performed in the following sequence.

**WARNING: MAKE SURE THAT ALL POWER IS SHUT OFF TO THE STARTER-GENERATOR BEFORE REMOVING OR REPLACING COMPONENTS OR ASSEMBLIES. TAKE EXTREME CARE WHEN PERFORMING "LIVE" CIRCUIT TESTS AND TROUBLESHOOTING PROCEDURES. DURING OPERATION, THE STARTER-GENERATOR PRODUCES A VERY HIGH AMPERAGE OUTPUT THAT CAN CAUSE SEVERE SHOCK OR DEATH.**

### A. Continuous operating speed and equalizing voltage.

(1) Install thermocouple on the outside of the stator and housing assembly (540) in an area adjacent to a stator main pole.

(2) Install a second thermocouple in the air inlet opening.

(3) For models 23080-002, -004, -023, -023A, -056 and -058, operate starter-generator at 12,000 rpm, 30 VDC ($V_2$), 400 A ($V_1$/$SH_1$), until stabilized. Refer to Paragraph 4.

(4) For models 23080-023B, -059, 23291-005 and -067, operate starter-generator at 12,000 rpm, 30 VDC ($V_2$), 300 A ($V_1$/$SH_1$), until stabilized. Refer to Paragraph 4.

(5) For model 23080-075, operate starter-generator at 12,800 rpm, 30 VDC ($V_2$), 300 A ($V_1$/$SH_1$), until stabilized. Refer to Paragraph 4.

(6) Measure and record inlet air temperature.

(7) Measure and record winding or frame temperature.

(8) Measure and record the voltage between terminals D and E ($V_4$).

NOTE: For starter-generators identified with a MOD modification status, the measured equalizing voltage between terminals D and E must be multiplied by a correction factor as indicated in Table 1004.

NOTE: Models 23080-023A, 23080-023B, 23080-056, 23080-059, 23291-005, 23291-006 and 23291-007 use no correction factor.

| Model | MOD | Correction Factor (CF) |
|---|---|---|
| 23080-002 | F | 0.94 |
| 23080-004 | E | 0.94 |
| 23080-023 | G | 0.94 |
| 23080-058 | D | 0.94 |

Table 1004 - Correction Factor

(9) Acceptance limits:

The equalizing voltage must fall within the limits of Figure 1002, Figure 1003, Figure 1004, Figure 1005 or Figure 1006 depending on the model:

- Figure 1002: Models 23080-002, 23080-004, 23080-058
- Figure 1003: Model 23080-023
- Figure 1004: Model 23080-023A
- Figure 1005: Models 23080-023B, 23080-059, 23291-005, 23291-006 and 23291-007
- Figure 1006: Model 23080-056

(10) While the generator is still hot, immediately proceed to minimum speed for regulation test.

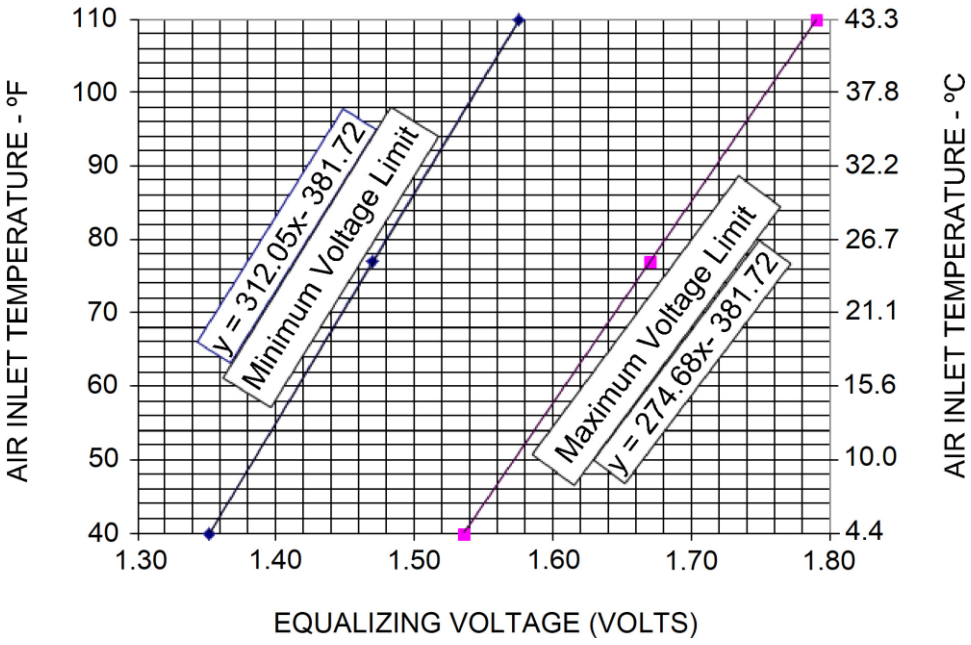


Figure 1002 - Equalizing Voltage Acceptance Limits
(Models: 23080-002, 23080-004 and 23080-058)

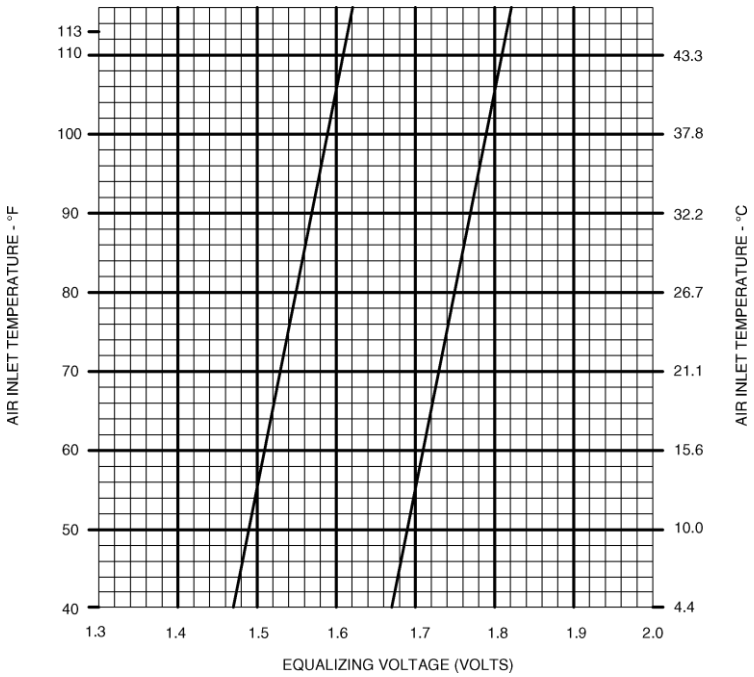


Figure 1003 - Equalizing Voltage Acceptance Limits
(Model 23080-023)

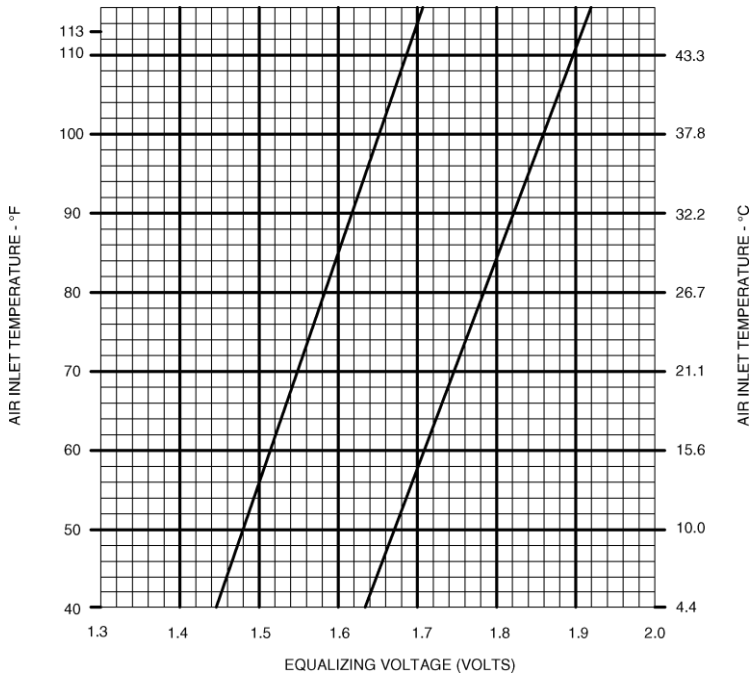


Figure 1004 - Equalizing Voltage Acceptance Limits
(Model 23080-023A)

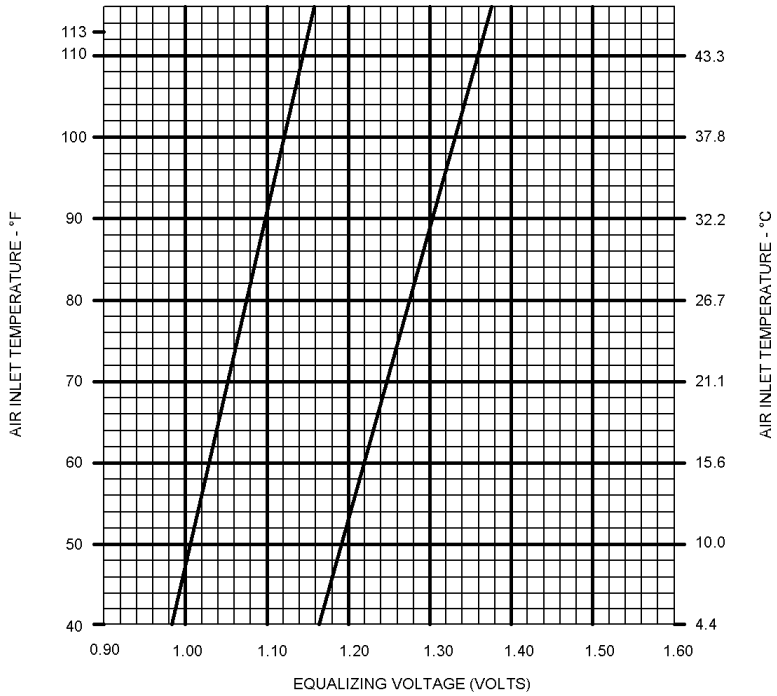


Figure 1005 - Equalizing Voltage Acceptance Limits
(Models: 23080-023B, 23080-059, 23291-005, 23291-006 and 23291-007)

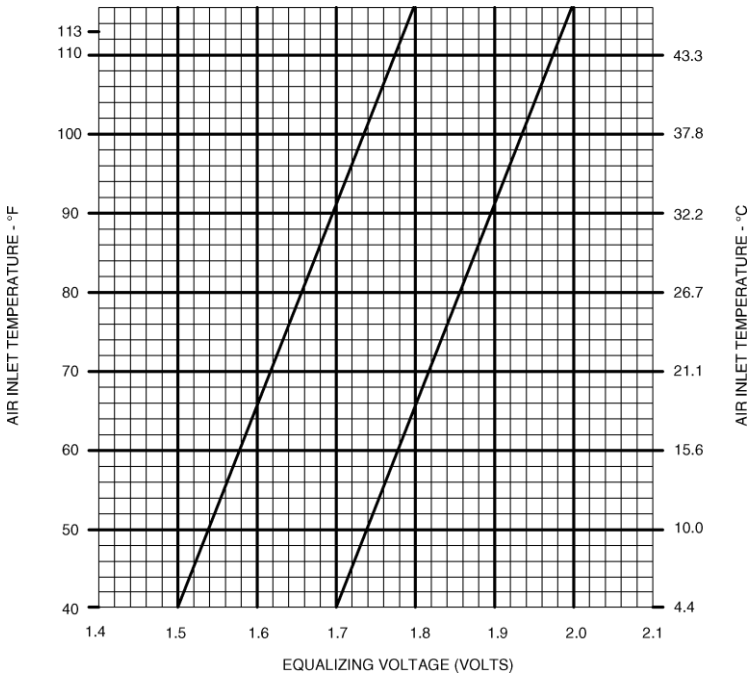


Figure 1006 - Equalizing Voltage Acceptance Limits (Model 23080-056)

**B. Minimum speed for regulation test:**

(1) Operate starter-generator with the applicable conditions given in Table 1005. Stabilization not required.

| Model Number | rpm | VDC ($V_2$) | A ($V_1$/$SH_1$) |
|---|---|---|---|
| 23080-002, 23080-004, 23080-058 | 7,200 | 30 | 400 |
| 23080-023, 23080-023A, 23080-023B, 23080-056, 23080-059, 23291-005, 23291-006, 23291-007 | 6,600 | 29.5 | 250 |

Table 1005 - Speed Regulation Characteristics

(2) Measure and record voltage between terminals B and A ($V_3$).

(3) Measure and record field current ($A_1$).

(4) Calculate and record external field circuit resistance between terminals B and A by dividing the B to A voltage ($V_3$) by the field current ($A_1$).

(5) For all models, except 23080-056, open the field circuit ($SW_3$) and record residual voltage B to E.

(6) Acceptance limits:

The acceptance limits are as given in Table 1006.

| Model | Output Voltage | Field Current | External Field Resistance | Residual Voltage B to E |
|---|---|---|---|---|
| 23080-056 | 29.3 to 29.7 VDC | Must not be more than 10 A | 0.4 Λ or more | Not applicable |
| 23080-002<br>23080-004<br>23080-023<br>23080-023A<br>23080-023B<br>23080-058<br>23080-059<br>23291-005<br>23291-006<br>23291-007 | Not applicable | Must not be more than 10 A | 0.4 Λ or more | 0.8 VDC or more |

Table 1006 - Series IV Starter-Generator Acceptance Limits

**C. Minimum speed test.**

NOTE: Test not applicable to model 23080-056

(1) For models 23080-002, -004, -023, -023A and -058, operate starter-generator at 6,800 rpm, 28.0 VDC ($V_2$) and 400 A for 15 minutes with air supply tube disconnected.

(2) For models 23080-023B, -059, 23291-005, -067 and -075, operate starter-generator at 6,800 rpm, 28.0 VDC ($V_2$) and 300 A for 15 minutes with air supply tube disconnected.

(3) Measure and record voltage between terminals B and A ($V_3$).

(4) Measure and record field current ($A_1$).

(5) Calculate and record external field circuit resistance between terminals B and A by dividing the B to A voltage ($V_3$) by the field current ($A_1$).

(6) Acceptance limits:

(a) The field current must not be more than 10 A.

(b) The calculated external field resistance must be 0.4 Λ or more.

**D. Overspeed test.**

(1) With starter-generator still hot as a result of testing, increase speed to 14,000 rpm (with field switch open) for 5 minutes.

(2) Acceptance Limits:

(a) No indication of failure (throwing of varnish, solder, noise, vibration, loosening of parts).

**E. Commutation voltage.**

(1) For models 23080-002, -004, -023, -023A, -056 and -058, operate the starter-generator at 12,000 rpm, 30 VDC ($V_2$) with 400 A ($V_1$/SH1) load.

(2) For models 23080-023B, -059, 23291-005 and -067, operate the starter-generator at 12,000 rpm, 30 VDC ($V_2$) with 300 A ($V_1$/SH1) load.

(3) For model 23291-007, operate the starter-generator at 12,800 rpm, 30 VDC ($V_2$) with 300 A ($V_1$/SH1) load.

(4) Visually examine the condition of commutation.

NOTE: The proper angle for viewing commutation is approximately 30 to 45 degrees from the brush box as shown in Figure 1007.

(5) Acceptance Limits:

(a) Acceptable (pin point) commutation must be interpreted to permit continuous sparking that extends 0.12 inch (3,0 mm) beyond the edge of the brush (190) and occasional (no more than 10 per minute) single sparks that extend up to 0.25 inch (6,4 mm) beyond the edge of the brush (190).

(b) Unacceptable commutation is considered to be continuous sparking or “arcing” that extends 0.25 inch (6,4 mm) beyond the edge of the brush (190).

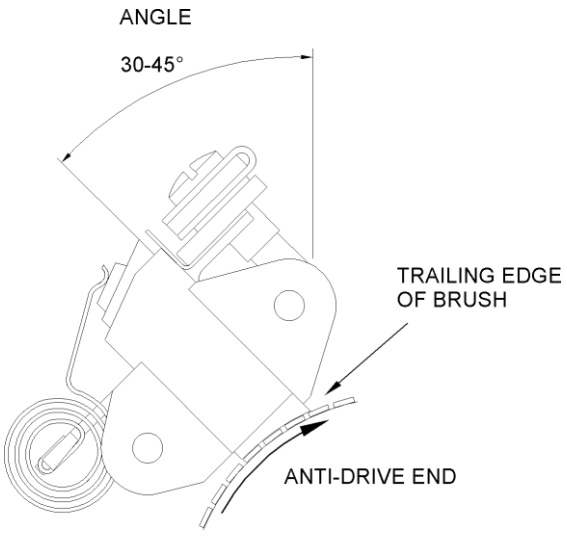


Figure 1007 - Correct Viewing Angles

## F. Speed pickup test.

NOTE: Test not applicable to model 23080-056.

(1) Connect a 20 kΛ ± 10% load across pins A and B of connector (360). See Figure 1008.

(2) Connect oscilloscope, set at 0.5 v/cm and 5 millisecond time sweep, across pins A and B of connector (360).

(3) With field switch ($SW_3$) open, adjust starter-generator speed to 6,000 rpm.

(4) Adjust oscilloscope for display of 2 or 3 cycles.

(5) Measure and record peak-to-peak voltage of speed pickup output voltage.

(6) Observe speed pickup output voltage waveforms.

(7) Acceptance Limits:

(a) Peak-to-peak voltage: 2.5 V Min. to 4.5 V Max.

(b) Refer to Figure 1009 for acceptable voltage waveform.

(c) Models 23080-023, 23080-023A, 23080-023B, 23080-059, 23291-005, 23291-006 and 23291-007 have signal frequency requirements of 4000 to 4400 Hz.

NOTE: If unacceptable results are reached, adjust air gap of speed pickup for correct voltage reading and waveform.

(8) Disconnect and remove load from pins A and B of connector (360).

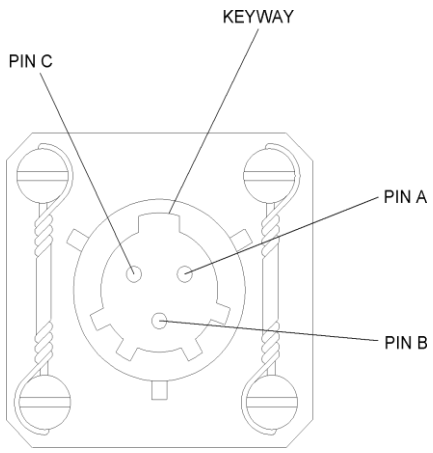


Figure 1008 - 3-Pin Connector

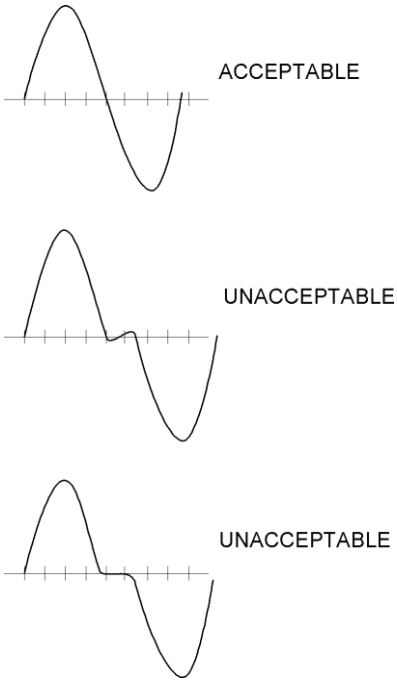


Figure 1009 - Acceptable Voltage Waveform

**G. Starter-generator dielectric test.**

**WARNING: BEFORE USING HIGH VOLTAGE TESTER, MAKE CERTAIN TESTER HAS BEEN TURNED "OFF" AND THAT NO ONE IS TOUCHING ANY PORTION OF CONNECTION POINTS OR PROBE LEAD WIRES. FAILURE TO COMPLY WITH THIS WARNING CAN RESULT IN SEVERE ELECTRIC SHOCK TO THE OPERATOR OR ASSISTANTS.**

**CAUTION:** DO NOT PERFORM DIELECTRIC TESTING DURING MAINTENANCE INSPECTION OR TROUBLESHOOTING OF THE UNIT AS IT MAY CAUSE CUMULATIVE DEGRADATION OF THE ELECTRICAL CIRCUIT INSULATION. THIS TEST IS RECOMMENDED ONLY FOR ACCEPTANCE TESTING OF AN OVERHAULED UNIT THAT HAS BEEN THOROUGHLY CLEANED.

(1) Disconnect starter-generator from test circuit.

(2) Remove commutation viewing adapter.

(3) While machine is still hot as a result of testing, connect all stator terminal leads (A+, B+, D and E-), or (A+, B+, C+, D and E-) for model 23080-056, of the terminal block together.

(4) Attach positive (red) lead of high pot tester to connected terminal leads.

(5) For models 23291-005, -067 and -075: attach a jumper to the shaft of the starter-generator and to an unfinished surface on the stator housing to establish a good grounding connection.

NOTE: Arcing between the stator housing and the shaft will occur at the speed pickup sensor during the high potential dielectric test if not grounded. The shaft is electrically isolated only in bench test when the new ceramic hybrid bearings are used.

(6) Attach negative (black) lead of high pot tester to an unfinished surface of the starter-generator frame.

**WARNING: FAILURE TO USE NECESSARY SAFETY PRECAUTIONS WHEN HANDLING HIGH VOLTAGE ELECTRICAL LEADS DURING HIGH POTENTIAL TESTING CAN CAUSE SERIOUS INJURY OR DEATH.**

**CAUTION:** INCREASE OR DECREASE THE TEST VOLTAGES SLOWLY (100 V PER SECOND, MAXIMUM). INCREASING OR DECREASING THE VOLTAGE TOO QUICKLY CAN CAUSE SERIOUS DAMAGE TO THE STARTER-GENERATOR.

(7) Apply dielectric test voltage of 250 V rms for one minute or 300 V rms for one second (commercial frequency) between the circuit and machine frame.

(8) Slowly decrease voltage to zero.

(9) Turn the power supply OFF.

(10) Disconnect the electrical test leads from the test unit.

(11) Acceptance Limits:

(a) Any arcing as evidenced by flashover (surface discharge), sparkover (air discharge), breakdown (puncture discharge) or leakage current more than 5 mA will be evidence of damp, dirty, weak or defective components.

**H. Speed pickup dielectric test.**

NOTE: Test not applicable to model 23080-056.

**WARNING: BEFORE YOU USE THE HIGH VOLTAGE TESTER, MAKE SURE THAT THE POWER SWITCH IS IN THE 'OFF' POSITION. MAKE SURE THAT NO PERSON TOUCHES THE EQUIPMENT OR THE PROBES. THIS WILL PREVENT DEATH OR INJURY FROM ELECTRIC SHOCK.**

**CAUTION:** DO NOT DO DIELECTRIC TESTING ON A MACHINE THAT HAS NOT BEEN FULLY CLEANED.

(1) Connect pins A and B of connector (360) together. See Figure 1008.

(2) Attach positive (red) lead of high pot tester to connected terminal leads.

(3) Attach negative (black) lead of high pot tester to an unfinished surface of the starter-generator frame.

**CAUTION:** INCREASE OR DECREASE THE TEST VOLTAGES SLOWLY (100 V PER SECOND, MAXIMUM) INCREASING OR DECREASING THE VOLTAGE TOO QUICKLY CAN CAUSE SERIOUS DAMAGE TO THE STARTER-GENERATOR.

(4) Apply dielectric test voltage of 250 V rms for one minute (commercial frequency) between combined connector pins and machine frame.

(5) Slowly decrease voltage to zero.

(6) Turn the power supply OFF.

(7) Disconnect the electrical test leads from the test unit.

(8) Acceptance Limits:

(a) Any arcing as evidenced by flashover (surface discharge), sparkover (air discharge), breakdown (puncture discharge) or leakage current more than 2 mA will be evidence of damp, dirty, weak or defective components.

## I. Locked rotor test

NOTE: This test is only applicable to starter-generators which have been overhauled and have an armature with a resurfaced commutator. Reference Standards Practice Document 1001.

(1) Rigidly mount starter-generator to test stand by starter-generator mounting flange.

(2) Connect 0.0 Λ jumper between terminals A and B as shown in Figure 1010 or Figure 1011.

(3) With voltage output set to zero, turn power supply ON.

**CAUTION:** DO NOT ENERGIZE STARTER-GENERATOR MORE THAN 4 SECONDS. TURN POWER OFF IMMEDIATELY IF POWER IS MORE THAN VOLTAGE AND AMPS OF ACCEPTANCE LIMITS.

(4) For shunt start models, (all models except 23080-056), increase voltage between terminals B and E ($V_2$) until output torque is 20.0 lbf.ft (27,1 N·m).

(5) For series start, model 23080-056, increase voltage between terminals C and E ($V_2$) until torque is 20.0 lbf.ft (27,1 N·m).

NOTE: If current or voltage is more than acceptable limits before the required torque is measured, remove power. Rotate armature to a different orientation and repeat test.

(6) Measure and record line current ($V_1/SH_1$).

(7) Measure and record voltage between terminals B and E ($V_2$) or C and E ($V_2$).

(8) Turn the power supply OFF.

(9) Acceptance limits

The acceptance limits are as given in Table 1007.

| Model Number | B-E or C-E Voltage | LINE CURRENT |
|---|---|---|
| 23080-002, 23080-004, 23080-023, 23080-023A, 23080-023B, 23080-058, 23080-059 23291-005, 23291-006, 23291-007 | Not more than 10 VDC | Not more than 800 A |
| 23080-056 | Not more than 12 VDC | Not more than 600 A |

Table 1007 - Locked Rotor Test Acceptance Limits

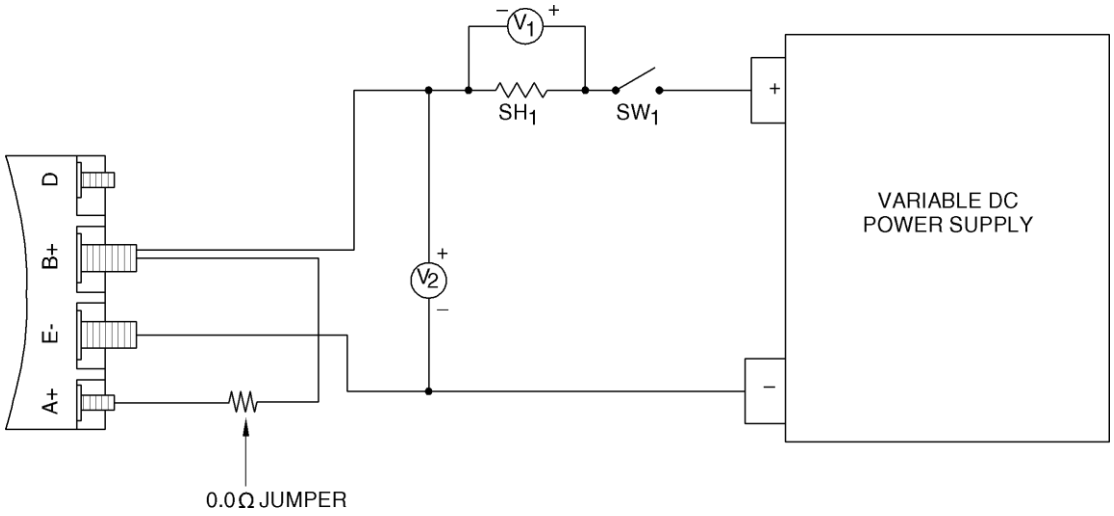


Figure 1010 - Locked Rotor Test Connection Diagram, Shunt Start

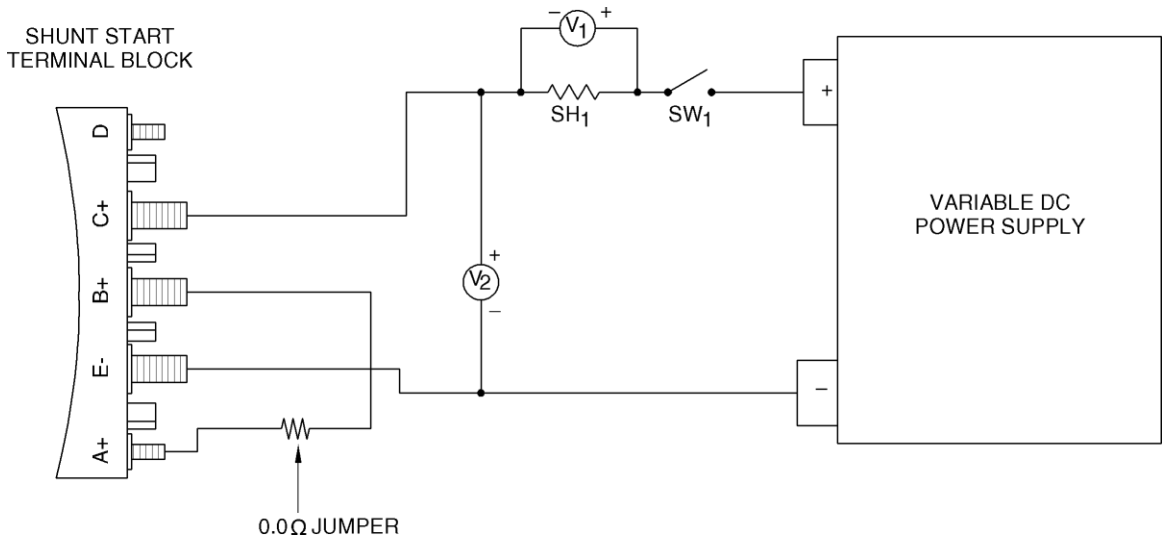


Figure 1011 - Locked Rotor Test Connection Diagram, Series Start

**J. Commutator runout.**

**CAUTION:** DO NOT TOUCH THE POLISHED COMMUTATOR SURFACE WITH BARE HANDS. SKIN ACIDS AND OILS CAN CONTAMINATE CONDUCTING SURFACES, CAUSING CORROSION OR POOR ELECTRICAL CONTACT.

(1) Rotate armature on its own bearings and measure bar-to-bar and total runout.

(2) Acceptance Limits:

(a) Bar-to-Bar Runout: 0.0002 inch (0,005 mm) Max.

(b) Total Indicated Runout: 0.0008 inch (0,020 mm) Max.

## 8. Final Assembly After Acceptance Testing

After starter-generator has successfully completed and passed acceptance testing, refer to the ASSEMBLY section for final assembly instructions.

## 9. Fault Isolation Tables

The following tables list faults that can occur during acceptance testing, performance testing, or when starter-generator is in service. For each fault, probable causes are listed along with related corrective actions. When a fault is detected, perform the corrective actions necessary to return the starter-generator to a serviceable condition. A complete acceptance test is required after corrective action is accomplished.

| Fault | Probable Cause | Corrective Action |
|---|---|---|
| A. Continuous Operating Speed, Equalizing Voltage and Minimum Speed Test | | |
| High Equalizing Voltage ($V_4$). | Cooling air flow is low. | Check air flow path for obstructions.<br><br>Clear all obstructions. |
| | Brushes are not properly seated. | Perform brush run-in procedure. Refer to SPD 1006. |
| | Loose brush lead(s). | Inspect all brush leads for loose connections.<br><br>If loose brush lead is found and no evidence of arcing is present, secure brush lead to complete brush holder.<br><br>If loose brush is found and evidence of arcing is present, REPLACE brush. |
| | Brush circuit(s) open. | Inspect all brush leads for an open circuit.<br><br>If open circuit found, overhaul or repair starter-generator as necessary. |
| | Armature is shorted or grounded. | Clean armature. Refer to CLEANING section.<br><br>Perform dielectric test on armature according to procedure in CHECK section.<br><br>If armature fails dielectric tests, check armature for a short with a growler. Refer to the CHECK section.<br><br>If armature fails growler check, replace armature. |
| | Stator and housing assembly is shorted or grounded. | Clean stator and housing assembly. Refer to CLEANING section.<br><br>Perform dielectric test on stator and housing assembly according to procedure in CHECK section.<br><br>If stator and housing assembly fails dielectric tests, replace stator and housing assembly. |

Table 1008 - Fault Isolation Table

| Fault | Probable Cause | Corrective Action |
|---|---|---|
| Field current ($A_1$) limit is exceeded. | Excessive load applied during testing. | Check and adjust applied load at load bank, as necessary. |
| Low external field resistance. | Cooling air flow is low. | Check air flow path for obstructions.<br><br>Clear all obstructions. |
| | Brushes are not properly seated. | Perform brush run-in procedure. Refer to SPD 1006. |
| | Brushes hung up in complete brush holder. | Inspect for proper positioning. |
| | Commutator surface incorrectly filmed or irregular. | Check armature. Refer to CHECK section.<br><br>Repair commutator surface or replace armature. Refer to REPAIR section.<br><br>Perform brush run-in procedure. Refer to SPD 1006. |
| | Armature is shorted or grounded. | Clean armature. Refer to CLEANING section.<br><br>Perform dielectric test on armature according to procedure in CHECK section.<br><br>If armature fails dielectric tests, check armature for a short with a growler. Refer to the CHECK section.<br><br>If armature fails growler check, replace armature. |
| | Stator and housing assembly is shorted or grounded. | Clean stator and housing assembly. Refer to CLEANING section.<br><br>Perform dielectric test on stator and housing assembly according to procedure in CHECK section.<br><br>If stator and housing assembly fails dielectric tests, replace stator and housing assembly. |
| B. Minimum Speed for Regulation Test | | |
| Field current ($A_1$) limit is exceeded. | Excessive load applied during testing. | Check and adjust applied load at load bank, as necessary. |

Table 1008 - Fault Isolation Table (Continued)

| Fault | Probable Cause | Corrective Action |
|---|---|---|
| Low external field resistance. | Cooling air flow is low. | Check air flow path for obstructions.<br><br>Clear all obstructions. |
| | Brushes are not properly seated. | Perform brush run-in procedure. Refer to SPD 1006. |
| | Brushes hung up in complete brush holder. | Inspect for proper positioning. |
| | Commutator surface incorrectly filmed or irregular. | Check armature. Refer to CHECK section.<br><br>Repair commutator surface or replace armature. Refer to REPAIR section.<br><br>Perform brush run-in procedure. Refer to SPD 1006. |
| | Armature is shorted or grounded. | Clean armature. Refer to CLEANING section.<br><br>Perform dielectric test on armature according to procedure in CHECK section.<br><br>If armature fails dielectric tests, check armature for a short with a growler. Refer to the CHECK section.<br><br>If armature fails growler check, replace armature. |
| | Stator and housing assembly is shorted or grounded. | Clean stator and housing assembly. Refer to CLEANING section.<br><br>Perform dielectric test on stator and housing assembly according to procedure in CHECK section.<br><br>If stator and housing assembly fails dielectric tests, replace stator and housing assembly. |

Table 1008 - Fault Isolation Table (Continued)

| Fault | Probable Cause | Corrective Action |
|---|---|---|
| C. Overspeed Test | | |
| Noisy Operation. | Bearings are defective and/or installed incorrectly. | Replace bearings. |
| | Cooling fan blades rubbing or are out of balance. | Check fan blades and air inlet for damage.<br><br>Replace cooling fan if damaged.<br><br>Repair or replace air inlet if damaged.<br><br>NOTE: There are no authorized repair procedures to balance cooling fans. |
| | Drive shaft spline is worn. | Disassemble drive shaft from starter-generator.<br><br>Inspect drive shaft IAW Paragraph 8.J. of the CHECK section.<br><br>Repair or replace drive shaft as necessary. |
| | Armature striking against the stator and housing assembly. | Disassemble starter-generator. Check both parts for physical damage. Repair or replace damaged parts as necessary. |
| Starter-Generator vibrates. | Bearings are defective and/or installed incorrectly. | Visually inspect bearings.<br><br>Disassemble starter-generator and replace bearings as necessary. |
| | Armature is out of balance. | Disassemble starter-generator.<br><br>Check armature balance. Refer to SPD 1001.<br><br>Repair or replace armature as necessary in accordance with SPD 1001. |

Table 1008 - Fault Isolation Table (Continued)

| Fault | Probable Cause | Corrective Action |
|---|---|---|
| D. Commutation Test | | |
| Too much sparking with no load. | Brushes are not properly seated. | Perform brush run-in procedure. Refer to SPD 1006. |
| | One or more complete brush holders are loose. | Check attaching hardware.<br><br>If damage is found, REPAIR bearing and brush support assembly as necessary.<br><br>Perform dielectric test on bearing and brush support assembly according to procedure in CHECK section.<br><br>Perform brush run-in procedure. Refer to SPD 1006. |
| | Brush spring pressure below limit. | Check brush spring pressure. Refer to SPD 1006.<br><br>REPLACE brush springs that do not meet limits in FITS AND CLEARANCES section. |
| | An armature winding is partially or completely open. | REPLACE armature. |

Table 1008 - Fault Isolation Table (Continued)

| Fault | Probable Cause | Corrective Action |
|---|---|---|
| Excessive sparking with no load. (Continued) | Commutator surface incorrectly filmed or irregular. | Check armature. Refer to CHECK section.<br><br>REPAIR commutator surface or replace armature. Refer to REPAIR section.<br><br>Perform brush run-in procedure. Refer to SPD 1006. |
| | Stator and housing assembly is shorted or grounded. | Clean stator and housing assembly. Refer to CLEANING section.<br><br>Perform dielectric test on stator and housing assembly according to procedure in CHECK section.<br><br>If stator and housing assembly fails dielectric tests, REPLACE stator and housing assembly. |
| | Armature is out of balance. | Check armature balance. Refer to SPD 1001.<br><br>REPAIR or REPLACE armature as necessary. |
| E. Speed Pickup Test | | |
| No output voltage. | Speed pickup leads are shorted to starter-generator frame. | Check for continuity between starter-generator frame and speed pickup leads.<br><br>Replace speed pickup if continuity is found. |
| | Speed pickup coil or lead wires are open. | Check speed pickup for continuity between speed pickup leads.<br><br>Replace speed pickup if continuity is not found. |

Table 1008 - Fault Isolation Table (Continued)

| Fault | Probable Cause | Corrective Action |
|---|---|---|
| Output voltage not within limits. | Incorrect air gap between speed pickup and spur gear. | CAUTION:<br>DO NOT ADJUST THE AIR GAP WHILE THE STARTER-GENERATOR IS OPERATING. ADJUSTING THE AIR GAP DURING OPERATION CAN DAMAGE THE EQUIPMENT.<br><br>Adjust air gap to be within following limits: 0.006 to 0.008 inch (0,15 to 0,20 mm). |
| | Low output. | Reduce air gap. See Caution. |
| | High output. | Increase air gap. See Caution. |
| Speed pickup waveform is incorrect. | Incorrect air gap between speed pickup and spur gear. | Adjust air gap to be within following limits: 0.006 to 0.008 inch (0,15 to 0,20 mm). See Caution. |
| | Speed pickup spur gear is damaged. | Replace speed pickup spur gear. |
| | Speed pickup is damaged. | Replace speed pickup. |

Table 1008 - Fault Isolation Table (Continued)

| Fault | Probable Cause | Corrective Action |
|---|---|---|
| F. Starter-Generator Dielectric Test | | |
| Starter-Generator insulation breakdown. | Bearing and brush support assembly is grounded. | Disassemble the starter-generator.<br><br>Clean bearing and brush support assembly. Refer to CLEANING section.<br><br>Perform dielectric test on bearing and brush support assembly according to procedure in CHECK section.<br><br>If bearing and brush support assembly fails dielectric test, replace insulating sleeves and washers, according to the procedures in the disassembly and assembly section. |
| | Armature is grounded. | Disassemble the starter-generator.<br><br>Clean armature. Refer to CLEANING section.<br><br>Perform dielectric test on armature according to procedure in CHECK section.<br><br>If armature fails dielectric tests, check armature for a short with a growler. Refer to the CHECK section.<br><br>If armature fails growler check, replace armature. |
| | Stator and housing assembly is grounded. | Clean stator and housing assembly. Refer to CLEANING section.<br><br>Perform dielectric test on stator and housing assembly according to procedure in CHECK section.<br><br>If stator and housing assembly fails dielectric tests, replace stator and housing assembly. |

Table 1008 - Fault Isolation Table (Continued)

| Fault | Probable Cause | Corrective Action |
|---|---|---|
| G. Speed Pickup Dielectric Test | | |
| Speed pickup insulation breakdown. | Lead wires are grounded to stator and housing assembly or speed pickup has short to ground. | Check for continuity between starter-generator frame and speed pickup leads.<br><br>Replace speed pickup if continuity is found. |
| H. Locked Rotor Test | | |
| Low or no torque. | Stator and housing assembly is shorted or grounded. | Clean stator and housing assembly. Refer to CLEANING section.<br><br>Perform dielectric test on stator and housing assembly according to procedure in CHECK section.<br><br>If stator and housing assembly fails dielectric tests, replace stator and housing assembly. |
| | Armature is shorted or grounded. | Clean armature. Refer to CLEANING section.<br><br>Perform dielectric test on armature according to procedure in CHECK section.<br><br>If armature fails dielectric tests, check armature for a short with a growler. Refer to the CHECK section.<br><br>If armature fails growler check, replace armature. |
| | Brushes incorrectly seated or installed. | Remove the brush cover.<br><br>Using a wire hook tool, pull brush sets away from commutator surface.<br><br>CHECK commutator surface for damage.<br><br>REPAIR, if limits are not exceeded in FITS AND CLEARANCES.<br><br>Perform brush run-in procedure. Refer to SPD 1006.<br><br>Re-test starter-generator. |

Table 1008 - Fault Isolation Table (Continued)

| Fault | Probable Cause | Corrective Action |
|---|---|---|
| Low or no torque. (Continued) | Open brush circuit. | Remove the brush cover.<br><br>Inspect all brush leads for an open circuit.<br><br>If an open circuit is found, replace brush (new brush only).<br><br>Perform brush run-in procedure. Refer to SPD 1006.<br><br>Re-test starter-generator. |
| Calculated efficiency is below minimum limit. | Windings hot from testing. | Allow the windings to cool.<br><br>Repeat test. |
| | Field current is low. | Check field circuit for high resistance. |
| | Brushes are incorrectly seated or installed. | Refer to SPD 1006 for brush installation, seating, and run-in procedures. |
| Time to reach specified rpm exceeds minimum limit. | Windings hot from testing. | Allow the windings to cool.<br><br>Repeat test. |
| | Field current is low. | Check field circuit for high resistance. |
| | Brushes are incorrectly seated or installed. | Refer to SPD 1006 for brush installation, seating, and run-in procedures. |

Table 1008 - Fault Isolation Table (Continued)

| Fault | Probable Cause | Corrective Action |
|---|---|---|
| Line current ($V_1$/$SH_1$) or voltage between terminals B and E ($V_2$) exceeded. | Stator and housing assembly is shorted or grounded. | Disassemble the starter-generator.<br><br>Clean stator and housing assembly. Refer to CLEANING section.<br><br>Perform dielectric test on stator and housing assembly according to procedure in CHECK section.<br><br>If stator and housing assembly fails dielectric tests, replace stator and housing assembly. |
| | Armature is shorted or grounded. | Disassemble the starter-generator.<br><br>Clean armature. Refer to CLEANING section.<br><br>Perform dielectric test on armature according to procedure in CHECK section.<br><br>If armature fails dielectric tests, check armature for a short with a growler. Refer to the CHECK section.<br><br>If armature fails growler check, replace armature. |
| I. Commutator Runout Check | | |
| Bar-to-bar runout or total indicated runout exceeded. | Shifted commutator bars. | REPAIR commutator surface.<br><br>REPLACE armature if not repairable. |

Table 1008 - Fault Isolation Table (Continued)

## 10. Component Testing Fault Isolation Table

Wherever possible in the component testing fault isolation procedures, repairs are made. When repair is not possible, replace components.

| Fault | Probable Cause | Corrective Action |
|---|---|---|
| A. Stator and Housing Assembly Dielectric Test | | |
| Insulation breakdown | Stator and housing assembly is shorted or grounded. | Clean stator and housing assembly. Refer to CLEANING section.<br><br>Perform dielectric test on stator and housing assembly according to procedure in CHECK section.<br><br>If stator and housing assembly fails dielectric tests, replace stator and housing assembly. |
| B. Armature Dielectric Test | | |
| Insulation breakdown | Armature is shorted or grounded. | Clean armature. Refer to CLEANING section.<br><br>Perform dielectric test on armature according to procedure in CHECK section.<br><br>If armature fails dielectric tests, clean armature. Refer to CLEANING section. Repeat dielectric test on armature according to procedure in CHECK section.<br><br>If armature fails dielectric tests after a second cleaning, repeat test between commutator bars and retaining bands. |

Table 1009 - Component Testing Fault Isolation Table

| Fault | Probable Cause | Corrective Action |
|---|---|---|
| C. Armature Dielectric Test, Between Commutator Bars and Retaining Bands | | |
| Insulation breakdown | Grounded armature | Clean armature. Refer to CLEANING section.<br><br>Perform dielectric test on armature according to procedure in CHECK section.<br><br>If armature fails dielectric tests, clean armature. Refer to CLEANING section. Repeat dielectric test on armature according to procedure in CHECK section.<br><br>If armature fails dielectric tests after a second cleaning, replace armature. |

Table 1009 - Component Testing Fault Isolation Table (Continued)

| Fault | Probable Cause | Corrective Action |
|---|---|---|
| D. Bearing and Brush Support Assembly Dielectric Test | | |
| Insulation breakdown | Grounded armature. | Clean bearing and brush support assembly. Refer to CLEANING section.<br><br>Note: Leads for filter capacitor should be disconnected.<br><br>Perform dielectric test on bearing and brush support assembly according to procedure in CHECK section.<br><br>If bearing and brush support assembly fails dielectric test, clean bearing and brush support assembly. Refer to CLEANING section.<br><br>Repeat dielectric test on bearing and brush support assembly according to procedure in CHECK section.<br><br>If bearing and brush support assembly fails dielectric test after a second cleaning, replace insulating sleeves and washers.<br><br>Repeat dielectric test on bearing and brush support assembly according to procedure in CHECK section.<br><br>If bearing and brush support assembly fails dielectric tests after replacement of insulating sleeves and washers, replace bearing and brush support assembly. |

Table 1009 - Component Testing Fault Isolation Table (Continued)

## 23291 Series VERIFICATION / FINAL ACCEPTANCE DATA SHEET

Model Number:_____ Inspected by:_____

Serial Number:_____ Date:_____

Modification Level:_____

| Inspection/Test | Requirements/Limits | Measurements | Accept | Reject |
|---|---|---|---|---|
| Visual inspection | Check for physical damage | | | |
| Continuous Operating Speed and Equalizing Voltage Test | Inlet air temperature | °F (°C) | | |
| | Winding or frame temperature | °F (°C) | | |
| | Measured equalizing voltage D to E ($V_4$) | VDC | | |
| Minimum Speed for Regulation Test | Voltage between terminals B and A ($V_3$) (Model 23291-005 only) | VDC | | |
| | Field current ($A_1$) (10 A Max) | A | | |
| | Calculated external field circuit resistance (0.4 Λ Min) | Λ | | |
| Residual Voltage Test | B to E residual voltage (0.8 V DC minimum). (All Models except 23291-006 | VDC | | |
| Minimum Speed Test | Field current ($A_1$) (10 A Max) | A | | |
| | Voltage between terminals B and A ($V_3$): | VDC | | |
| | Calculated external field circuit resistance<br><br>(0.4 Λ Min) | Λ | | |
| Overspeed Test | No sign of electrical or mechanical failure | | | |
| Commutation Test | Not to exceed pinpoints | | | |

| Inspection/Test | Requirements/Limits | Measurements | Accept | Reject |
|---|---|---|---|---|
| Speed Pickup Test | Peak-to-peak voltage (2.5 to 4.5 VDC) | VDC | | |
| | Voltage waveform | [redacted] | | |
| | Frequency signal (4000 to 4400 Hz) (Models 23291-006 -007 | Hz | | |
| | Speed pickup resistance Part No 23291-1400: 20 to 45 Λ Part 23291 -1280: 95 to 137 Λ | Λ | | |
| Starter-Generator Dielectric Test | No indication of insulation breakdown | [redacted] | | |
| Speed Pickup Dielectric Test | No indication of insulation breakdown (All models but 23291-005 | | | |
| Locked Rotor Test and Residual Voltage Test | Line Current ($V_1$/$SH_1$) (Model 23291-005 600 A Max) (All models except 23291-006 800 A Max) | A | | |
| | B to E voltage ($V_2$): (All models except 23291-005 10.0 VDC Max) C to E voltage ($V_2$): (Model 23291-006 12.0 VDC Max.) | VDC | | |
| Commutator Runout Test | Bar-to-bar runout (0.0002 inch (0,005 mm) Max) | inch (mm) | | |
| | Total indicated runout (0.0008 inch (0,020 mm) Max) | inch (mm) | | |

# SCHEMATICS AND WIRING DIAGRAMS

## 1. Introduction

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# DISASSEMBLY

## 1. Introduction

This section provides disassembly instructions for 23291 Series DC Starter-Generators. Disassemble only to the extent required to replace defective parts, unless complete overhaul is required. Additional disassembly of major components is not necessary unless specifically instructed in the CHECK or TESTING AND FAULT ISOLATION sections. Before disassembly, wipe exterior surfaces with a clean cloth to remove dust, dirt, or other foreign materials.

Do not remove threaded inserts. Refer to CHECK section for details.

Do not disassemble riveted parts. Refer to REPAIR section to determine whether part(s) can be replaced.

Do not open or desolder permanent connections unless replacement of worn, damaged, or defective parts is necessary. Tag electrical wires before removal. All soldering and desoldering procedures must be done to ANSI/IPC J-STD-001.

During overhaul, replace bearings, brushes and o-rings. Parts that have been removed during disassembly, such as, insulating parts, retaining rings, screws, self-locking nuts and lock washers, must be discarded regardless of their condition. The screws that attach the brush leads to the brush holder do not need to be replaced unless damaged.

NOTE: When a starter-generator is removed for service, the QAD kit and terminal block cover usually stay on the aircraft.

## 2. Disassembly Tools

In addition to standard shop tools, those special tools, fixtures, and equipment listed in Table 3001 are required for disassembly.

| Tools Description | Source/Figure Reference |
|---|---|
| Anti-Drive End Armature Shaft Adapter | Figure 9001 |
| Anti-Drive End Hub Support | Figure 9014 |
| Arbor Press | Commercially Available |
| Bearing and Brush Support Assembly Support | Figure 9013 |
| Bearing Puller (Snap-On A78 or Equivalent) | Commercially Available |
| Dampener Hub Driver | Figure 9006 |
| Drive End Armature Shaft Adapter | Figure 9002 |
| Drive End Outboard Hub Support | Figure 9015 |
| External Snap Ring Pliers | Commercially Available |
| Foam Cushion | Commercially Available |

Table 3001 - Disassembly Tools

| Tools Description | Source/Figure Reference |
|---|---|
| Horizontal Stator Support | Figure 9016 |
| Inner Race Bearing Driver | Figure 9004 |
| DELETED | |
| Plastic or Leather Mallet | Commercially Available |
| Spline Wrench | Figure 9019 |
| Tweezers | Commercially Available |
| Wire Hook Tool | Commercially Available |

Table 3001 - Disassembly Tools (Continued)

## 3. Disassembly Materials

Materials necessary for starter-generator Disassembly are listed in Table 3002.

NOTE: Disassembly materials are not available from Safran Power. All items can be purchased commercially.

**WARNING: BEFORE USING ONE OF THE FOLLOWING MATERIALS, BE AWARE OF ALL HANDLING, STORAGE, AND DISPOSAL PRECAUTIONS RECOMMENDED BY THE MANUFACTURER OR SUPPLIER. FAILURE TO COMPLY WITH THE RECOMMENDATIONS CAN RESULT IN SERIOUS INJURY, PHYSICAL DISORDER, OR DEATH.**

| Item | Description/Specification | Source (CAGE Code) |
|---|---|---|
| Foam Cushion | N/A | Commercially Available |
| Isopropyl Alcohol<br><br>See **WARNING** before using this material. | TT-I-735, Grade A<br><br>Flash Point: 53° F (12° C), FLAMMABLE.<br>Refer to the Material Safety Data (MSD) Sheet for the material for additional safety information. | Commercially Available |
| Masking Tape | N/A | Commercially Available |

Table 3002 - Disassembly Materials

## 4. Disassembly of DC Starter-Generator

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10001 of ILLUSTRATED PARTS LIST.

**A. Remove QAD mounting kit from starter-generator, if present.**

NOTE: The V-retainer coupling usually stays on the aircraft when the starter-generator is removed for service, check and inspection of the part is not required if not present.

NOTE: The mounting adapter coupling usually stays on the aircraft when the starter-generator is removed for service, check and inspection of the part is not required if not present.

(1) Loosen self-locking nut (10005-20) and remove V-retainer coupling (10005-10) from the starter-generator.

(2) Remove QAD and mounting adapter and seal assembly (10005-40) from starter-generator. See Figure 3001.

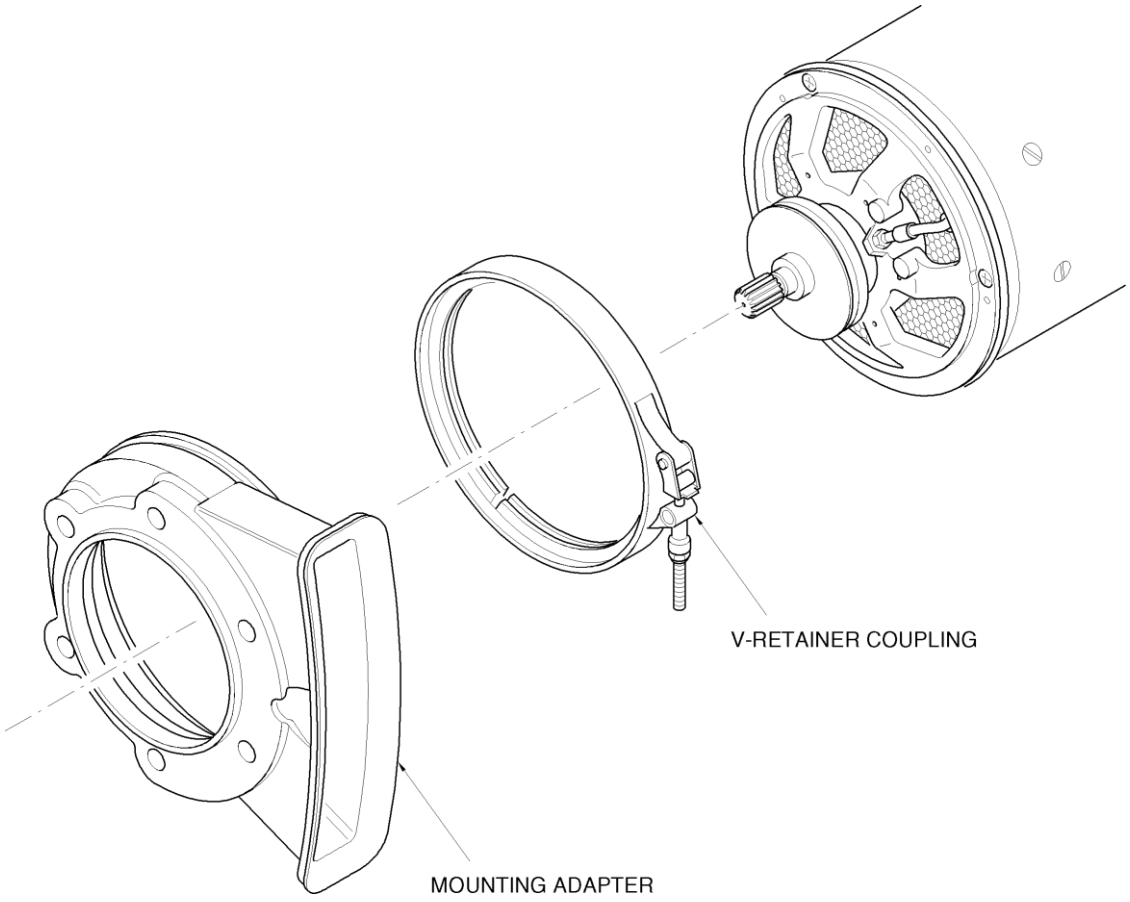


Figure 3001 - Removing the QAD Kit

**B. Remove the identification plate (10), caution decal (30), patent label (-40) and TSO label (-50) from stator and housing assembly (540).**

NOTE: Do not remove these items unless they are damaged or unreadable.

NOTE: Minor scratches and superficial damage that do not affect the legibility are not reason to replace the ID plate.

(1) Use a smooth, flat tool that will not scratch the stator housing to wedge under the edge of the identification plate and pry up on the corners of the plate near the four drive screws that hold it in place to dislodge the plate from the housing.

NOTE: This will tear the corners of the light metal identification plate.

(2) Remove the remaining metal from under the head of each drive screw.

(3) Use a small pair of sidecutters with the flat face to the housing to wedge in under the head of each drive screw to hold the shank of the screw and turn out counterclockwise.

(4) Discard the four drive screws (20) from the stator and housing assembly (540).

(5) Keep the identification plate for reference when transferring the information to a replacement identification plate (10).

**WARNING: HANDLE THE TOOL CAREFULLY. WEAR EYE PROTECTION.**

(6) Remove and discard the caution decal (30), patent label (-40) and TSO label (-50) from stator and housing assembly (540).

NOTE: The starter-generator may not have a TSO label (-50).

(a) Lift the corner of the caution decal, patent label and TSO label with a sharp tool.

(b) Peel off and discard the caution decal, patent label, and TSO label from the starter-generator.

**WARNING: ISOPROPYL ALCOHOL CAN BE DANGEROUS TO PERSONS. USE ONLY IN AN AREA WITH A GOOD FLOW OF AIR. KEEP AWAY FROM SOURCES OF IGNITION. DO NOT BREATHE THE FUMES. PREVENT SKIN CONTACT. PUT ON PROTECTIVE CLOTHING AND EYE PROTECTION.**

(c) Use isopropyl alcohol to remove adhesive residue.

(d) Wipe dry with a soft dry cloth.

**C. Remove terminal block cover (80) from terminal block.**

NOTE: When a starter-generator is removed from service, the terminal block cover is usually kept with the aircraft.

(1) For model 23080-056:

(a) Remove the two screws (-90) that attach the terminal block cover (80) to the terminal block. See Figure 3002.

(b) Remove the terminal block cover.

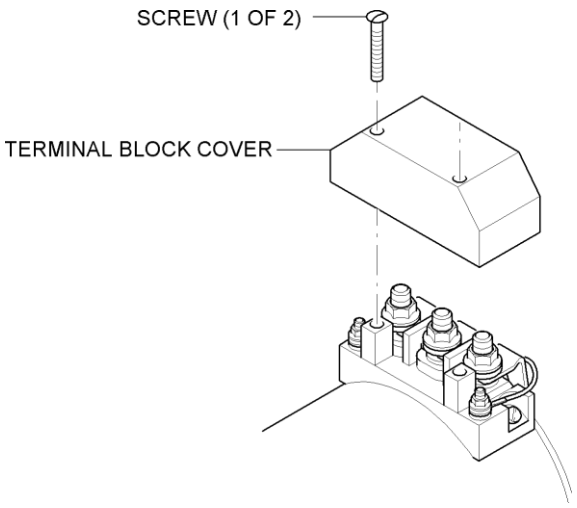


Figure 3002 - Removing the Terminal Block Cover (Model 23080-056)

(2) For all other models, remove the flexible terminal block cover (80).

**D. Remove air inlet (100) from bearing and brush support assembly (320) or fan shroud (130).**

(1) Remove lockwire from attaching screws of air inlet (100), discard lockwire.

(2) If air inlet (100) is attached to the bearing and brush support assembly (320) remove four screws (110). See Figure 3003.

(3) If air inlet is attached to fan shroud (130) remove five screws (110) and washers (120).

(4) Remove air inlet (100).

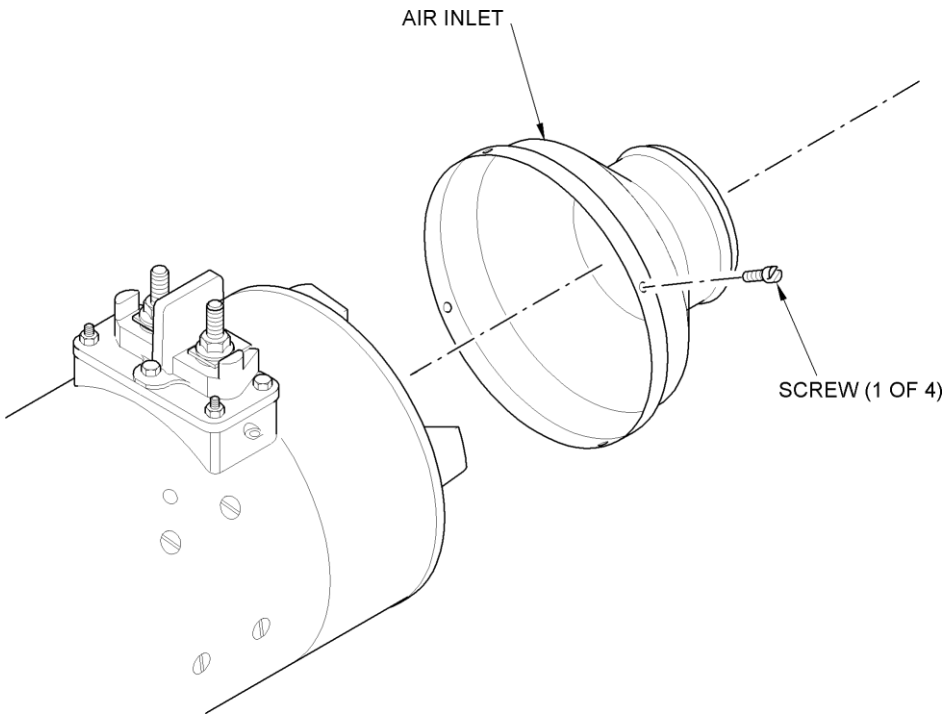


Figure 3003 - Removing the Air Inlet

**E. Remove fan shroud (130) from starter-generator (if applicable).**

(1) Remove lockwire from attaching screws of fan shroud (130), discard lockwire.

(2) Remove four screws (140) and washers (150) (model 23080-004 only) that attach fan shroud (130) to bearing and brush support assembly (320).

(3) Remove fan shroud (130).

**F. Remove brush access cover (160) from stator and housing assembly (540).**

(1) Remove screw (170) from self-locking blind rivet nut (180) that secures brush access cover around the stator and housing assembly. See Figure 3004.

(2) Remove brush access cover (160) from the stator and housing assembly.

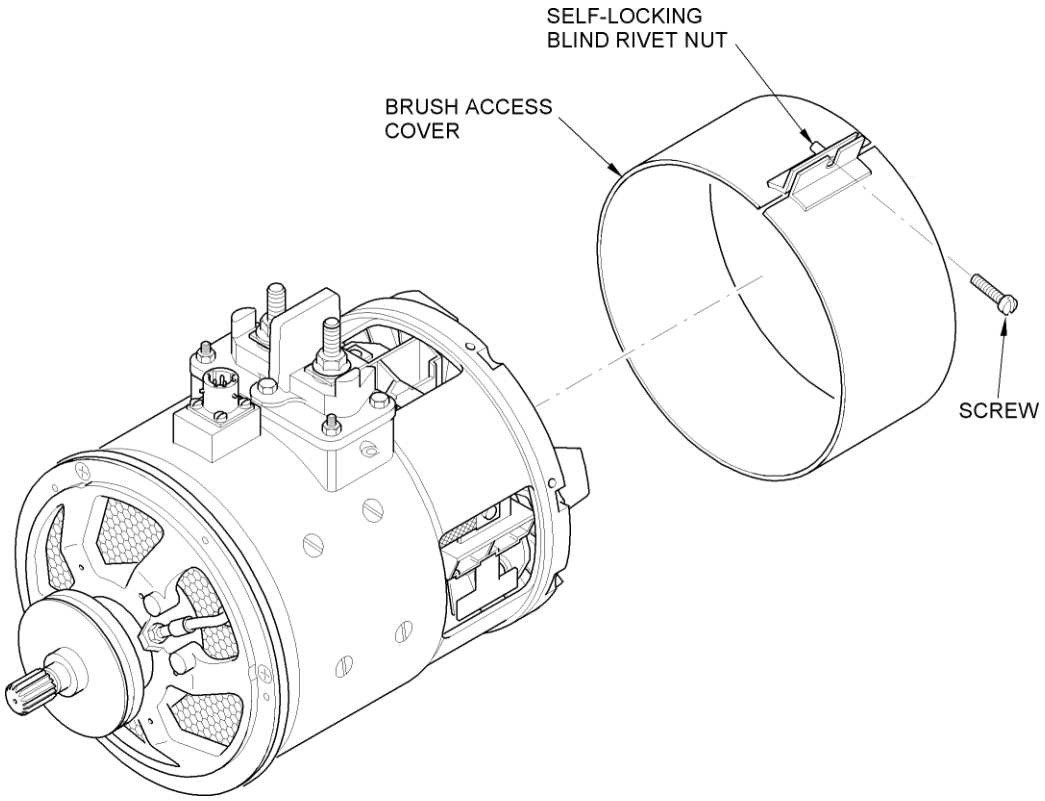


Figure 3004 - Removing the Brush Access Cover

**G. Remove brushes (190) from bearing and brush support assembly (320). See Figure 3005.**

NOTE: If brushes (190) are to be reused, identify the brushes and complete brush holders (10002-30) with the numbers 1 through 4.

(1) Remove four screws (200) that attach brushes (190) shunt leads to complete brush holders (10002-30).

**CAUTION:** RAISE AND LOWER BRUSH SPRINGS SLOWLY. DO NOT LIFT BRUSH SPRINGS MORE THAN NEEDED TO REMOVE BRUSHES FROM EACH COMPLETE BRUSH HOLDER.

(2) Use a wire hook tool to lift two brush springs (10002-130) away from brush (190). Remove brush from complete brush holder (10002-30).

(3) Slowly return brush springs (10002-130) to a resting position on complete brush holder (10002-30).

(4) Identify brush (190) with the number on complete brush holder (10002-30) from which it was removed.

(5) Repeat Paragraph 4.G.(2) through Paragraph 4.G.(4) for each remaining brush (190).

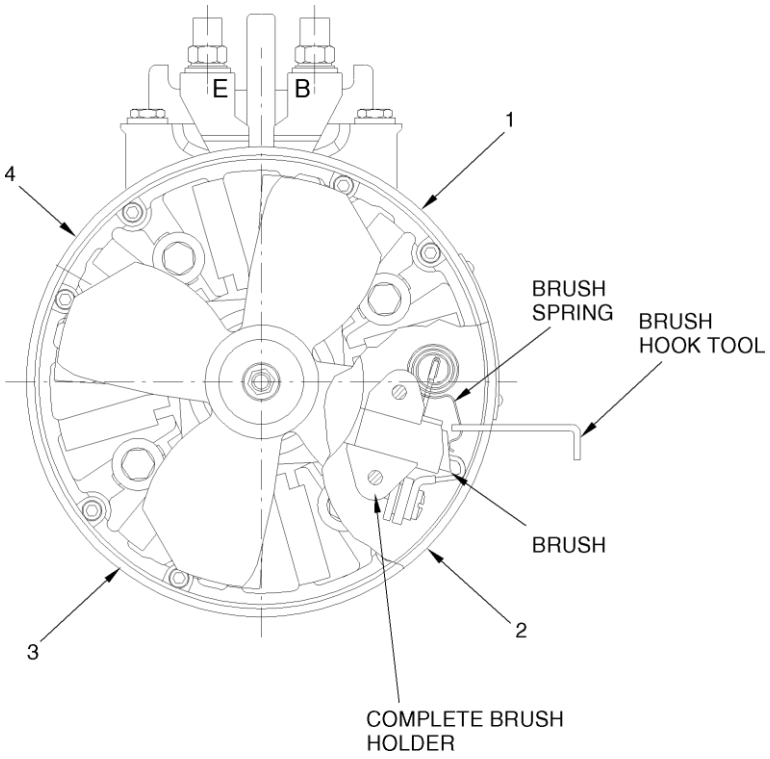


Figure 3005 - Numbering the Brush Holder Assemblies

**H. Remove fan (210) from drive shaft (240).**

(1) Put a spline wrench on the drive spline to prevent the drive shaft (240) from turning while removing the self-locking nut (220).

(2) Remove self-locking nut (220) and flat washer (230) from drive shaft (240). See Figure 3006.

(3) Slide fan (210) off of the drive shaft (240).

(4) Slide anti-drive end bearing shield (550) off the drive shaft (240).

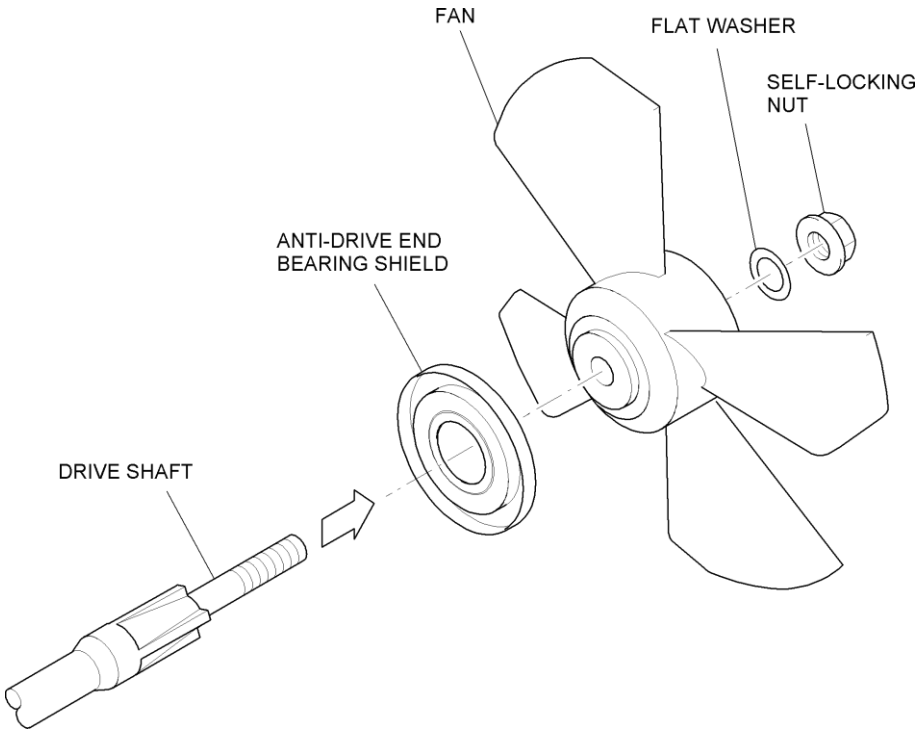


Figure 3006 - Removing the Fan from the Drive Shaft

**I. Remove drive shaft (240) with the attached O-ring (250), if applicable, dampener hub (280), dampener plate (270) and friction ring (260) from armature (500) shaft.**

**CAUTION:** DO NOT USE A HIGH AMOUNT OF FORCE WHEN YOU TAP THE DRIVE SHAFT. HIGH FORCE CAN DAMAGE THE DRIVE SHAFT THREAD.

(1) Lightly tap the anti-drive end of drive shaft (240) with a plastic or leather mallet to disengage it from armature (500) shaft.

(2) Pull drive shaft (240) out of the drive end of the starter-generator. See Figure 3007.

**WARNING: DO NOT CUT, RIP, OR SAND ASBESTOS-CONTAINING MATERIALS. LEAVE UNDAMAGED MATERIALS ALONE AND, TO THE EXTENT POSSIBLE, PREVENT THEM FROM BEING DAMAGED, DISTURBED, OR TOUCHED. DISCARD MATERIAL BY FIRST CHECKING WITH LOCAL HEALTH, ENVIRONMENTAL, OR OTHER APPROPRIATE OFFICIALS TO FIND OUT ABOUT PROPER HANDLING AND DISPOSAL PROCEDURES.**

(3) Remove friction ring (260) from drive shaft (240). If friction ring is Part No. 02-5600-05, it must be discarded because it contains asbestos.

(4) Remove dampener plate (270) from dampener hub (280) on drive shaft (240).

(5) If present, remove and discard O-ring (250) from drive shaft (240).

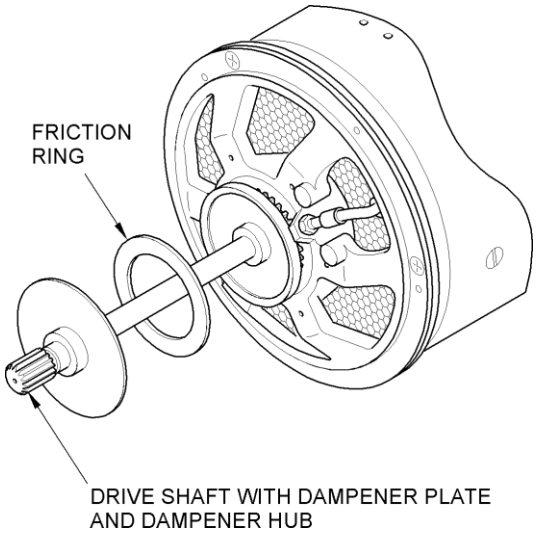


Figure 3007 - Removing The Drive Shaft, Friction Ring and Dampener Plate

**J. Remove dampener hub (280) from drive shaft (240). See** Figure 3008**.**

NOTE: Do not remove dampener hub from drive shaft unless hub or drive shaft are damaged.

**CAUTION:** PUT A FOAM CUSHION UNDER DRIVE SHAFT TO PREVENT IT FROM BEING DAMAGED.

(1) Set a foam cushion and a hub support on an arbor press table.

(2) Set a dampener hub driver on the drive shaft (240) on the flat side of dampener hub (280).

(3) Insert drive shaft (240) through the center of the hub support until dampener hub driver is installed on the hub support.

(4) Slowly press drive shaft (240) down into the hub support until dampener hub (280) disengages from draft shaft.

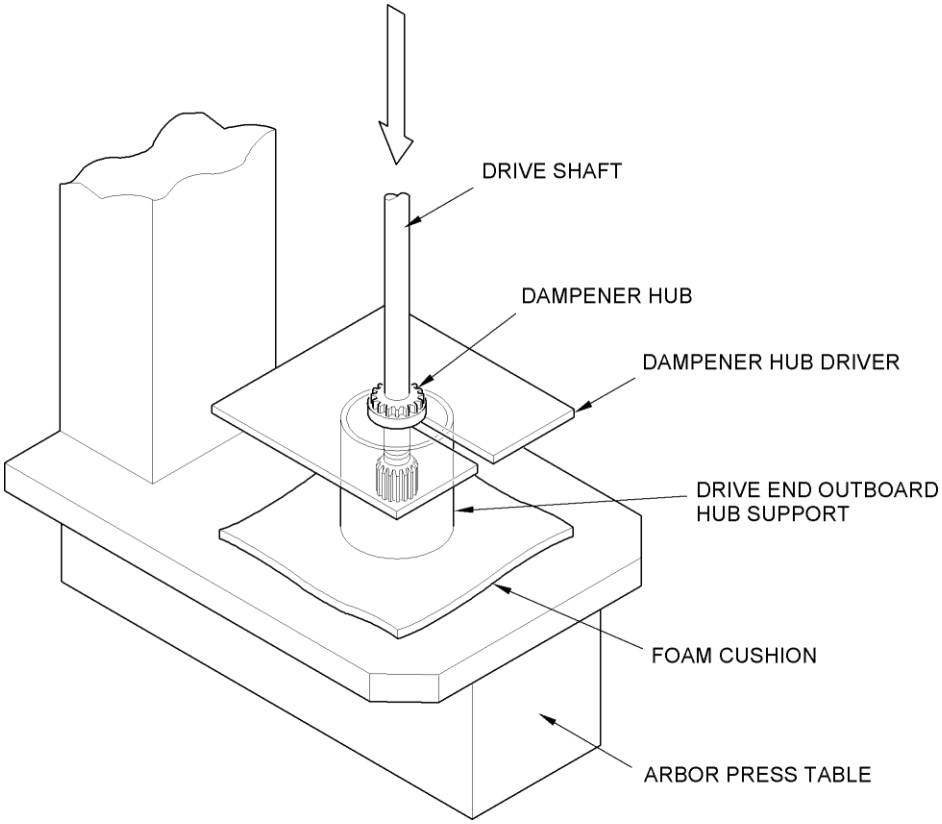


Figure 3008 - Remove the Dampener Hub from the Drive Shaft

**K. Remove dampener backplate (290), retaining ring (300), and speed pickup spur gear (310) from armature (500) shaft. See Figure 3009.**

**CAUTION:** FAILURE TO USE THE DRIVE END ARMATURE SHAFT ADAPTER WHEN REMOVING THE DAMPENER BACKPLATE AND SPUR GEAR CAN CAUSE PERMANENT DAMAGE TO THE ARMATURE SHAFT.

(1) Put drive end armature shaft adapter into the drive end of armature (500) shaft.

**CAUTION:** TAPE THE JAWS OF THE BEARING PULLER TO PREVENT DAMAGE TO THE DAMPENER BACKPLATE DURING REMOVAL.

(2) Remove dampener backplate (290) from armature (500) shaft using a suitable bearing puller.

(3) Use external snap ring pliers to remove and discard retaining ring (300).

(4) Remove speed pickup spur gear (310) using a suitable bearing puller and the shaft adapter.

(5) For model 23291-005 remove shaft spacer (430) from armature (500) shaft.

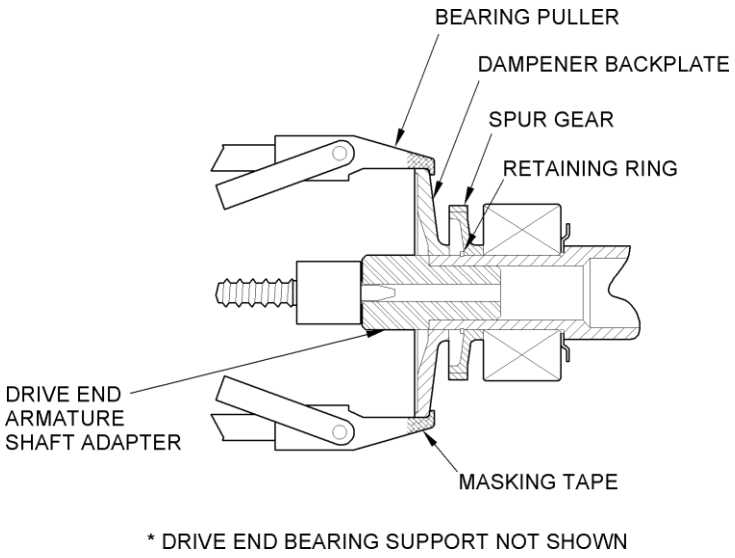


Figure 3009 - Removing the Dampener Backplate and Speed Pickup Spur Gear

**L. Remove bearing and brush support assembly (320) and attached armature (500) from stator and housing assembly (540) See Figure 3010.**

NOTE: For bearing pre-load models (see Table 4 in DESCRIPTION AND OPERATION), the drive end bearing (450) will remain in the drive end bearing support assembly when removing the armature. The spacer or DE bearing shield (350) will release when the armature with attached bearing and brush support assembly is removed. Make sure this part is not lost when the bearing and brush support assembly (320) and attached armature (500) are removed. For non-preload models refer to Paragraph 4.R. for removal of the drive end bearing (450).

(1) Set the starter-generator on a horizontal stator support.

**CAUTION:** FAILURE TO USE A DRIVE END ARMATURE SHAFT ADAPTER WHILE REMOVING THE BEARING AND BRUSH SUPPORT ASSEMBLY CAN CAUSE PERMANENT DAMAGE TO THE ARMATURE SHAFT.

(2) Remove eight self-locking screws (330) and eight flat washers (340) that attach the bearing and brush support assembly (320) to stator and housing assembly (540).

(3) Insert the drive end armature shaft adapter into the drive end of the armature (500) shaft.

(4) Gently tap on the drive end armature shaft adapter with a plastic or leather mallet until the bearing and brush support assembly (320) separates from the stator and housing assembly (540).

(5) Carefully remove the bearing and brush support assembly (320) and attached armature (500) from the stator and housing assembly (540).

(6) For bearing pre-load models, remove and retain the spacer or DE bearing shield (350) from the armature (500) shaft.

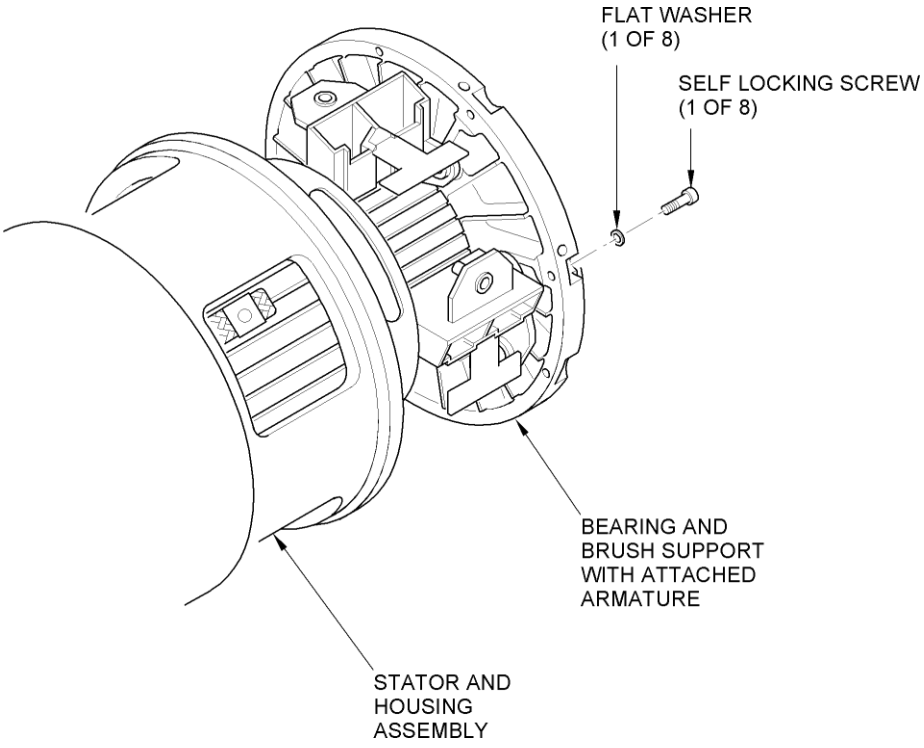


Figure 3010 - Remove the Bearing and Brush Support Assembly with Attached Armature

**M. Remove the 3-pin connector (360) and spacer (370) from stator and housing assembly (540). See** Figure 3011**.**

(1) Remove screw (70) and speed sensor clamp (60) from stator and housing assembly (540).

(2) Remove and discard the lockwire from four screws (380) that attach the 3-pin connector (360) and spacer (370) to stator and housing assembly (540).

(3) Remove four screws (380) and pull the connector (360) from stator and housing assembly (540) to length of electrical wire.

(4) Carefully desolder the leads from the pins.

NOTE: All desoldering procedures must be done to ANSI/IPC J-STD-001.

(5) Set 3-pin connector (360) and spacer (370) aside.

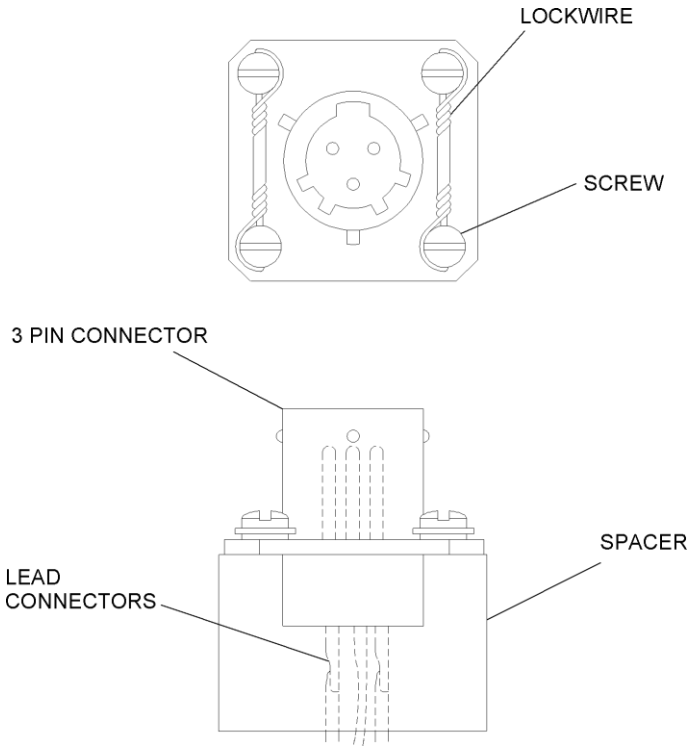


Figure 3011 - Remove Connector and Spacer from Stator and Housing Assembly

**N. Remove thermal switch (390)**

NOTE: Do not remove this item unless it is damaged.

(1) Unthread the thermal switch (390) from the stator and housing assembly (540) and discard.

**O. Remove drive end bearing support assembly (400) from stator and housing assembly (540). See** Figure 3012**.**

(1) Remove three screws (410) from stator and housing assembly (540).

**CAUTION:** DO NOT USE HIGH FORCE WHEN TAPPING DRIVE END BEARING SUPPORT ASSEMBLY OR YOU CAN DAMAGE THE MATING FLANGE OF THE STATOR AND HOUSING ASSEMBLY.

(2) Lightly tap the outer diameter of the drive end bearing support assembly (400) with a plastic or leather mallet to loosen it from the stator and housing assembly (540).

NOTE: Do not disassemble the stator and housing assembly (540).

(3) Remove drive end bearing support assembly (400) from stator and housing assembly (540) while pulling speed pickup (420) leads through the stator and housing assembly (540).

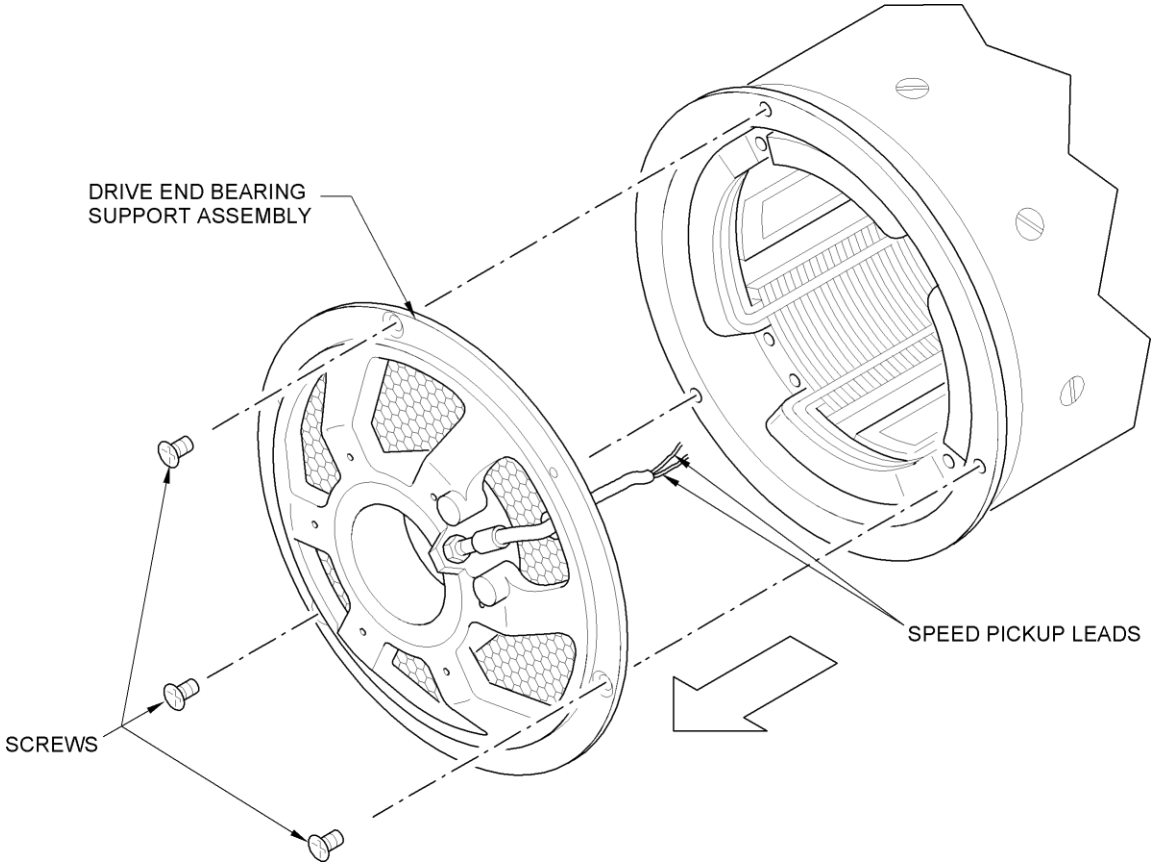


Figure 3012 - Removing the Drive End Bearing Support Assembly

**P. Remove speed pickup (420) and grommet (440) from the drive end bearing support assembly (400). See Figure 3013.**

(1) Pull speed pickup (420) leads through grommet (440).

NOTE: Do not disassemble the drive end bearing support assembly (400) unless damaged.

(2) Loosen speed pickup (420) jam nut and back it away from drive end bearing support assembly (400).

(3) Remove speed pickup (420) from drive end bearing support assembly (400).

(4) Remove and discard grommet (440) from drive end bearing support assembly (400).

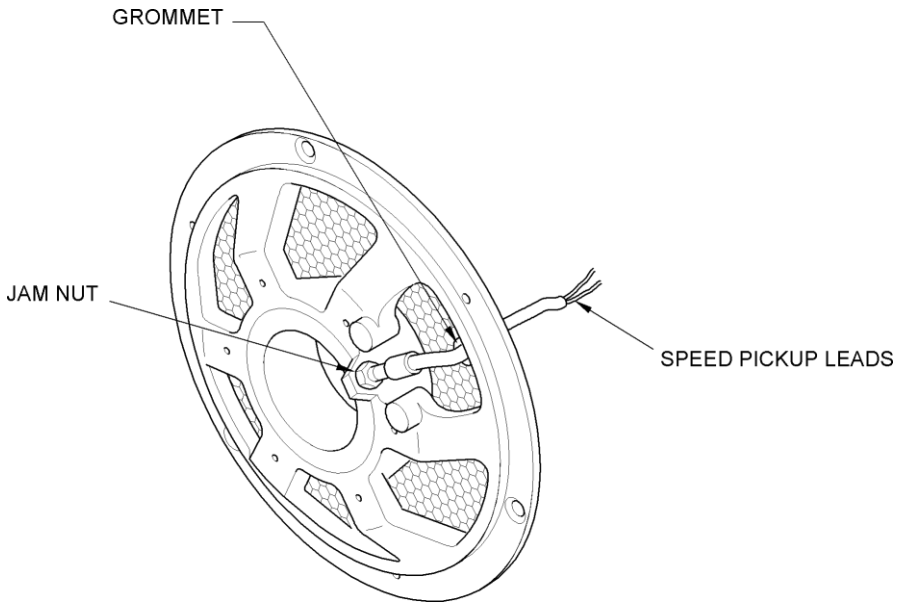


Figure 3013 - Removing the Speed Pickup

**Q. For bearing pre-load models, remove drive end bearing (450), spring wave washer (460) and shims (470, 480, 490) (if present) from the drive end bearing support assembly (400). See Figure 3014.**

NOTE: This instruction applies to starter-generators that have the bearing pre-load feature. (See Table 4 in DESCRIPTION AND OPERATION) For non-preload models refer to Paragraph 4.R.

**CAUTION:** FAILURE TO USE A DRIVE END OUTBOARD BEARING HUB SUPPORT CAN CAUSE PERMANENT DAMAGE TO ASSEMBLY.

(1) Position a drive end outboard hub support on the table of an arbor press.

(2) Position drive end bearing support assembly (400) on the outboard hub support.

(3) Set the inner race bearing driver on drive end bearing (450) in drive end bearing support assembly (400).

(4) Press drive end bearing (450) out of the bearing liner of drive end bearing support assembly (400).

(5) Remove drive end bearing (450) from inside of the outboard hub support. Discard bearing.

(6) Remove spring wave washer (460) and shim(s) (470, 480, 490) (if present) from the bearing liner of drive end bearing support assembly (400).

NOTE: The spring wave washer (460) can be reused if it passes the inspection criteria given in the CHECK section.

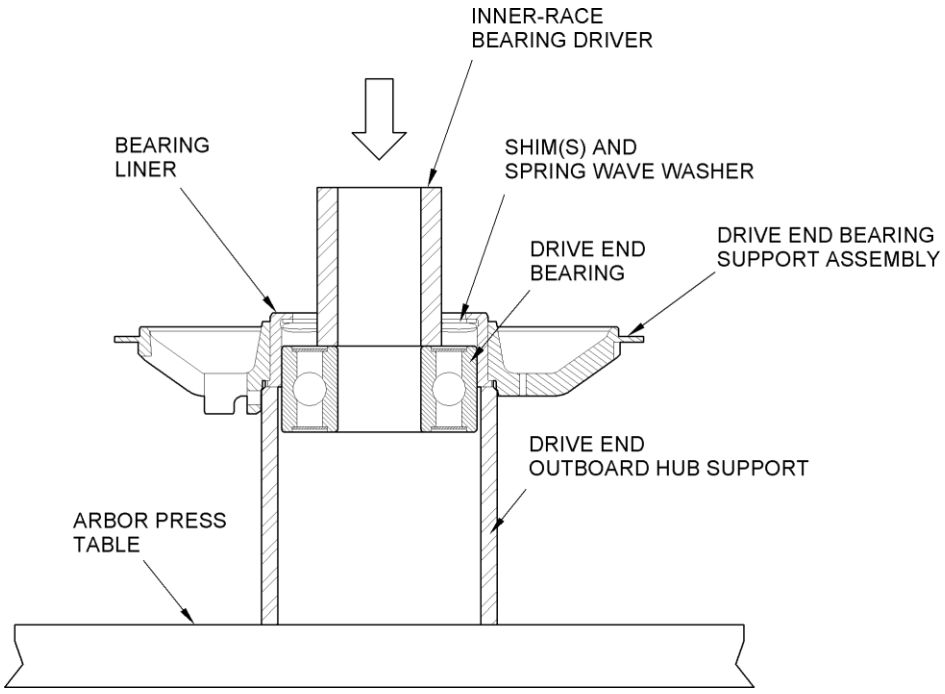


Figure 3014 - Removing the Bearing from the Drive End Bearing Support Assembly (Pre-Load)

**R. For bearing non-preload models, remove drive end bearing (450) and baffle disc (350) from armature (500) shaft. See Figure 3015.**

NOTE: This instruction applies to starter-generators that have the bearing non-preload feature.

**CAUTION:** FAILURE TO USE A DRIVE END ARMATURE SHAFT ADAPTER CAN CAUSE PERMANENT DAMAGE TO ASSEMBLY.

(1) Put drive end armature shaft adapter into armature (500) shaft.

(2) Using a suitable bearing puller, remove drive end bearing (450) from armature (500) shaft and discard bearing.

(3) Remove and retain baffle disc (350).

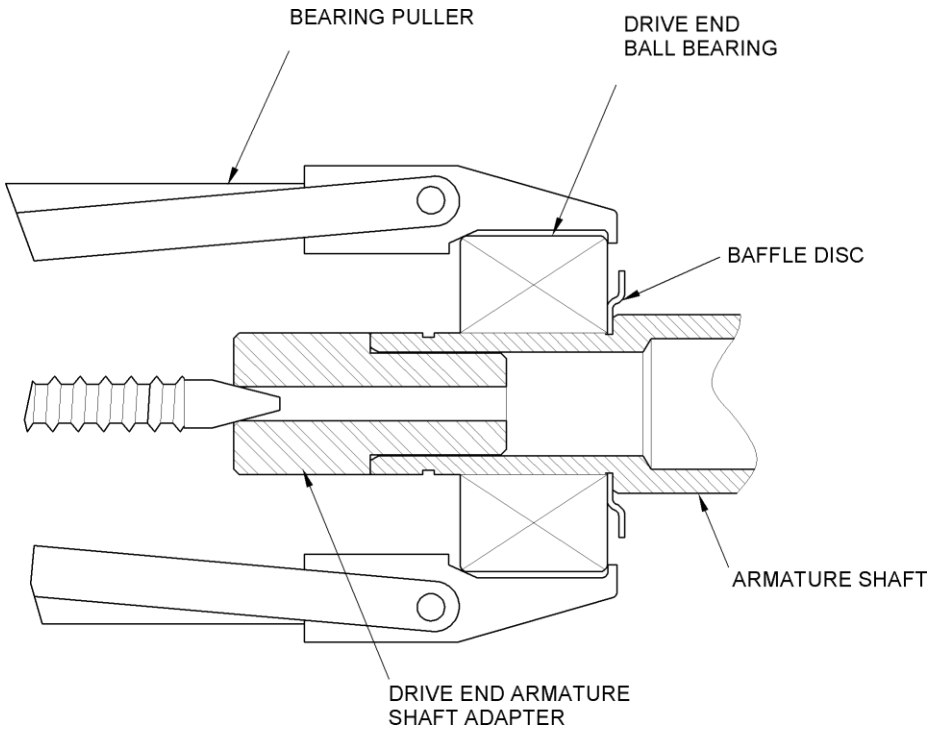


Figure 3015 - Remove Drive End Bearing and Baffle Disc (Non-Preload)

**S. Remove the armature (500) from the bearing and brush support assembly (320). See** Figure 3016**.**

**CAUTION:** TO PREVENT DAMAGE TO THE ARMATURE SHAFT, PUT A FOAM CUSHION AT THE BASE OF THE ANTI-DRIVE END BELL ASSEMBLY SUPPORT.

(1) Put a foam cushion and bearing and brush support assembly support on an arbor press table.

(2) Put the bearing and brush support assembly (320), with the attached armature (500), onto the bearing and brush support assembly support.

**CAUTION:** FAILURE TO USE THE ANTI-DRIVE END ARMATURE SHAFT ADAPTER WHEN PRESSING THE ARMATURE FROM THE BEARING AND BRUSH SUPPORT ASSEMBLY CAN CAUSE PERMANENT DAMAGE TO THE ARMATURE SHAFT.

(3) Insert an anti-drive end armature shaft adapter into the end of the armature (500) shaft.

**CAUTION:** TO PREVENT DAMAGE TO THE ARMATURE SHAFT, HOLD IT SECURELY WHEN IT IS PRESSED OUT OF THE BEARING AND BRUSH SUPPORT ASSEMBLY.

(4) Carefully press the armature (500) shaft down and away from the bearing and brush support assembly (320).

(5) Carefully remove armature (500) from inside the bearing and brush support assembly support.

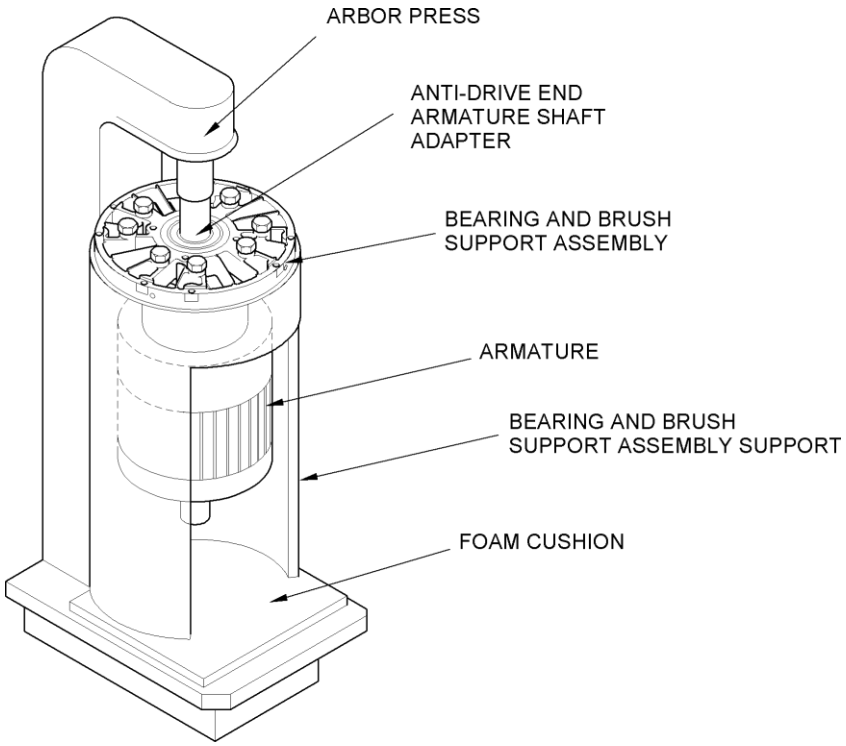


Figure 3016 - Remove the Armature from the Bearing and Brush Support Assembly

**T. Remove the bearing retainer (510) and bearing (530) from the bearing and brush support assembly (320). See** Figure 3017**.**

**CAUTION:** FAILURE TO USE AN ANTI-DRIVE END HUB SUPPORT WHEN BEARING IS PRESSED FROM THE ADE BEARING AND BRUSH SUPPORT ASSEMBLY CAN CAUSE PERMANENT DAMAGE TO THE BEARING AND BRUSH SUPPORT ASSEMBLY.

(1) Remove four screws (520) and bearing retainer (510) from bearing and brush support assembly (320).

(2) Set an anti-drive end hub support on the table of an arbor press.

(3) Set the bearing and brush support assembly (320) on the anti-drive end hub support with the inboard side facing up.

(4) Set an inner race bearing driver on the inner race of anti-drive end bearing (530).

(5) Slowly press anti-drive end bearing (530) from bearing and brush support assembly (320) using an inner race bearing driver.

(6) Remove anti-drive end bearing (530) from inside the anti-drive end hub support. Discard anti-drive end bearing.

NOTE: Do not disassemble the bearing and brush support assembly (320) unless damage is found.

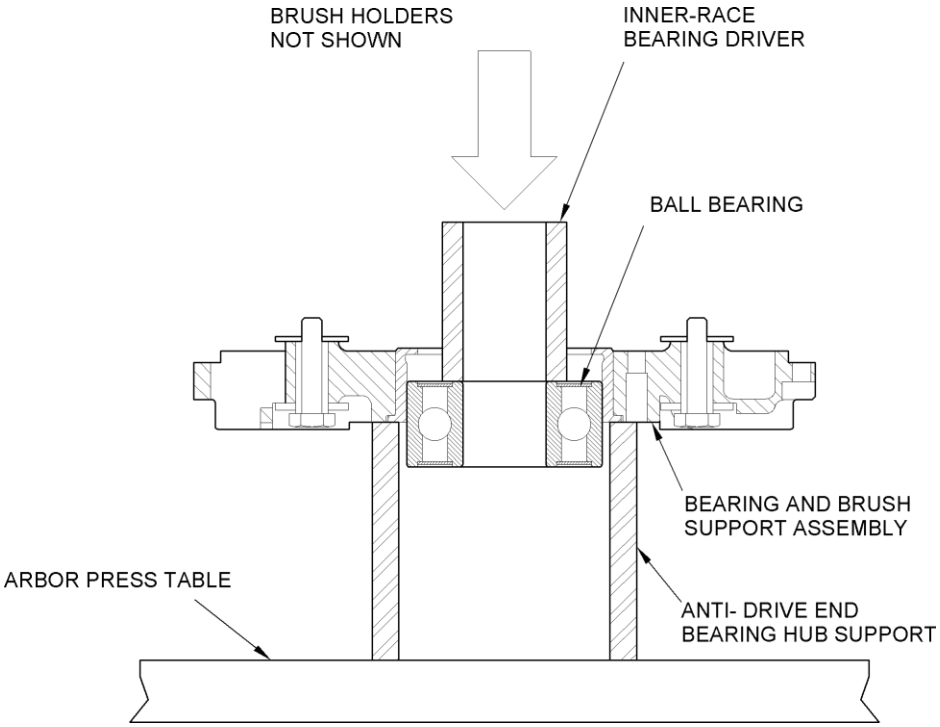


Figure 3017 - Removing the Anti-Drive End Ball Bearing

## 5. Disassembly of Bearing and Brush Support Assembly

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10002 of ILLUSTRATED PARTS LIST.

NOTE: Do not disassemble further than necessary to examine, repair or replace parts.

**A. Remove complete brush holder (30) assemblies from anti-drive end end bell (10).**

NOTE: Do not disassemble bearing and brush support assembly unless necessary.

(1) Remove two bolts (50), two nonmetallic washers (60), two flat washers (70), complete brush holder (30) and insulating board (90) from anti-drive end end bell (10).

(2) Remove two insulation sleeves (80) from mounting holes in anti-drive end end bell (10).

(3) Discard non-metallic washers (60) and insulation sleeves (80). Retain the insulating board (90).

(4) Remove two brush springs (130) from complete brush holder (30).

(5) Repeat Paragraph 5.A.(1) through Paragraph 5.A.(4) as required for remaining complete brush holders (30).

**B. Disassemble each complete brush holder (30) assembly.**

NOTE: Do not disassemble complete brush holders unless necessary.

(1) Refer to the REPAIR section for complete brush holder assembly (30).

## 6. Disassembly of the Drive End Bearing Support Assembly

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10003 of ILLUSTRATED PARTS LIST.

**A. Remove the screen guard (20) from the drive end end bell (10).**

NOTE: Do not remove the screen from the drive end end bell unless it is damaged.

(1) Remove and discard the attaching drive screws (30) and flat washers (40) from drive end end bell (10).

(2) Remove and discard screen guard (20) from drive end end bell (10).

## 7. Disassembly of the Stator and Housing Assembly

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10004 of ILLUSTRATED PARTS LIST.

NOTE: Do not disassemble the stator and housing assembly further than the removal of the terminal block to examine, repair, or replace parts determined to be unserviceable.

**A. Remove attaching hardware from the terminal block (80). See Figure 3018.**

(1) Remove screw (560) and flat washer (570) and remove terminal block grounding lead.

(2) For model 23080-056:

(a) From terminals B, C and E remove three nuts (10) and three flat washers (20). Discard flat washers.

(b) From terminals A and D remove two nuts (30) and two flat washers (40). Discard flat washers.

(3) For all other models:

(a) From terminals B and E remove two nuts (10) and two flat washers (20). Discard flat washers.

(b) From terminals A and D remove two nuts (30) and two flat washers (40). Discard flat washers.

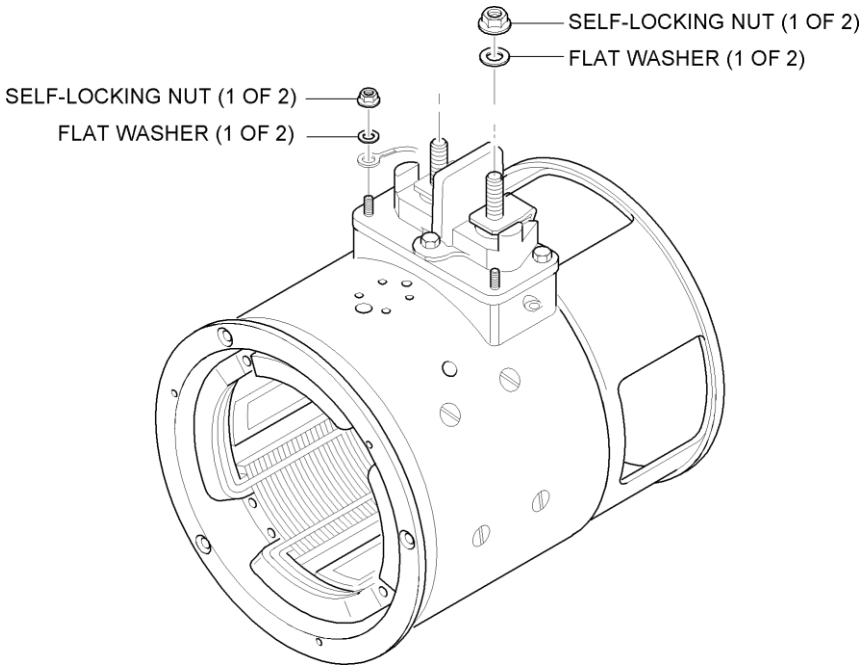


Figure 3018 - Removing Terminal Block Hardware

**B. Remove terminal block (80) from the housing. See** Figure 3019**.**

(1) For model 23080-056:

(a) Remove the two bolts (90), two lock washers (100) and two flat washers (120).

(b) Remove the wires from terminals A and D.

(c) Carefully remove the terminal block (80) from the stator leads.

(2) For all other models:

(a) Remove two bolts (90), two tab washers (100), two insulators (110), bolt (60) and tab washer (70) from terminal block (80). Discard tab washers and tab washer.

(b) Remove the wires from terminals A and D.

(c) Carefully remove the terminal block (80) from the stator leads.

(d) Remove the flat washer (150) from terminals B and E.

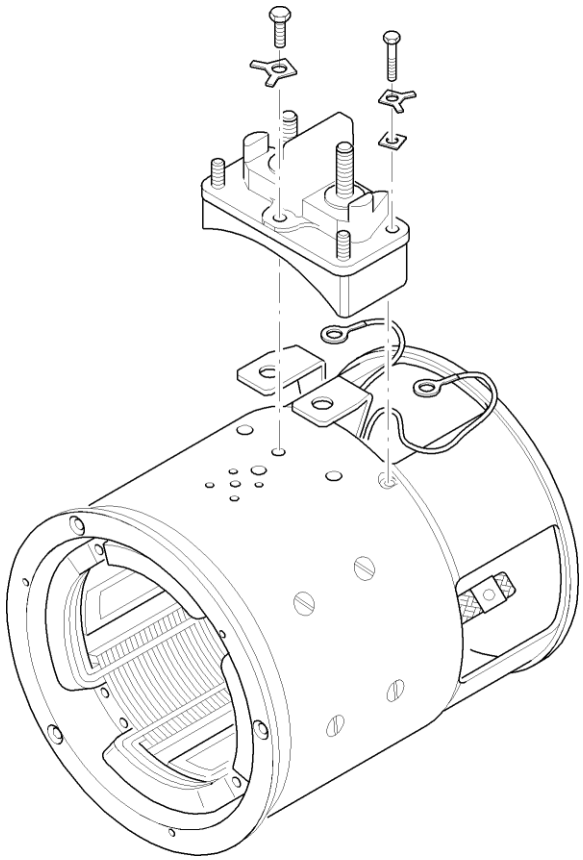

Figure 3019 - Removing the Terminal Block from the Housing

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# CLEANING

## 1. Introduction

This section contains the cleaning procedures for 23291 Series DC Starter-Generators.

## 2. Cleaning Materials

Table 4001 lists equipment and materials required to perform the cleaning of assemblies, subassemblies and components.

**WARNING: YOU MUST OBEY THE TOOL/EQUIPMENT MANUFACTURERS WARNINGS AND CAUTIONS SHOWN ON PACKAGING, CONTAINERS AND/OR INSTRUCTION LEAFLETS. IF YOU DO NOT, YOU CAN CAUSE DEATH OR INJURY TO PERSONS AND DAMAGE TO EQUIPMENT OR PROPERTY.**

**WARNING: ISOPROPYL ALCOHOL IS DANGEROUS TO PERSONS. USE ONLY IN AN AREA WITH A GOOD FLOW OF AIR. KEEP AWAY FROM SOURCES OF HEAT, SPARKS AND FLAME. DO NOT BREATHE THE FUMES. PREVENT SKIN CONTACT. PUT ON PROTECTIVE CLOTHING AND EYE PROTECTION.**

| Material | Description/Specification | Source/CAGE Code |
|---|---|---|
| Bag, Polyethylene | Size that will easily enclose parts being washed. | Commercially Available |
| Brush | Nonmetallic, soft bristle | Commercially Available |
| Cleaning Pads/Wiping Cloths | Lint-free, soft fabric | Commercially Available |
| Corrosion Preventive | Cold application, water displacing soft film MIL-C-16173, Grade 3. | Commercially Available |
| De-ionized Water | For fresh water, Ion Exchange process to a resistivity not less than 750 kΛ/cm @ 77° F (25° C) min., when measured in accordance with ASTM D1125-95, Method A.<br><br>For rinse water that is to be reused, check that the resistivity does not fall below 500 kΛ/cm @ 77° F (25° C) min., measured in accordance with ASTM D1125-95, Method A. | Commercially Available |

Table 4001 - Cleaning Materials and Equipment

| Material | Description/Specification | Source/CAGE Code |
|---|---|---|
| Desiccant | MIL-D-3464E Type II, Kraft bag, 4 unit bag size<br><br>Englehard Corporation Desiccate 25<br>or equivalent | Commercially Available |
| Detergent<br><br>Refer to material technical data sheet for recommended dilution of water and detergent, and solution temperature. | Formula 815 GD or GD-NF<br><br>Applications:<br>Hot tanks - aluminum safe<br>Steam Cleaning<br>Pressure Sprayers<br>Ultrasonic Cleaning | The Brulin Corporation<br>2920 Dr. Andrew J Brown Ave.<br>Indianapolis, Indiana 46205-4066 USA<br>Phone:(1) 317/923-3211<br>FAX: (1) 317/925-4596<br>www.brulin.com<br>(V94058) |
| | Formula 1990 GD<br><br>Application:<br>Spray Wash Cleaning | |
| Isopropyl Alcohol | TT-I-735, Grade A<br><br>See **WARNING** before using this material.<br><br>Flash Point: 53° F (12° C), FLAMMABLE<br><br>Refer to the Material Safety Data (MSD) Sheet for the material for additional safety information | Commercially Available |

Table 4001 - Cleaning Materials and Equipment (Continued)

## 3. Cleaning Procedures

Before you do procedures given in CHECK, REPAIR, ASSEMBLY, TESTING AND FAULT ISOLATION, and final inspection, the components must be cleaned, rinsed, and dried. All signs of moisture, oil, and other contamination must be removed from the internal structure of the generator to make sure all parts and circuits function correctly. Clean the starter-generator as follows:

### A. Blow out dirt particles.

(1) Put the parts into a ventilated air spray booth.

**WARNING:** **COMPRESSED AIR USED FOR CLEANING MUST BE FREE OF OIL AND WATER. WHEN USING COMPRESSED AIR FOR CLEANING OR DRYING, CONTROL PRESSURE TO 29 PSIG (200 KPA) OR LESS. WEAR GOGGLES OR FACE SHIELD TO PROTECT EYES. TAKE PRECAUTIONS TO AVOID INJURY TO OTHER PERSONNEL IN AREA.**

**CAUTION:** MAKE SURE THAT COMPRESSED AIR USED TO CLEAN/DRY THE COMPONENTS IS FREE FROM OIL AND WATER. THIS WILL PREVENT CONTAMINATION OF THE COMPONENTS.

(2) Blow away all loose dirt with clean, dry, compressed air.

**B. Clean the parts.**

**WARNING:** **DETERGENT CAN BE DANGEROUS TO PERSONS. USE ONLY IN AN AREA WITH A GOOD FLOW OF AIR. DO NOT BREATHE THE FUMES. PREVENT SKIN CONTACT. PUT ON PROTECTIVE CLOTHING AND EYE PROTECTION.**

Wash the parts with one or more of the approved cleaning procedures given in Table 4002.

| Procedure | Instructions |
|---|---|
| Spray | Put the parts into a high pressure spray wash booth using detergent Brulin 1990 GD. |
| | **CAUTION:** LIMIT THE PRESSURE TO CLEAN PARTS. HIGH PRESSURE CAN REMOVE OR DAMAGE SURFACE COATINGS, CONNECTIONS AND INSULATION. |
| | Spray the parts with a solution of detergent and de-ionized water. Refer to the manufacturers specification for the recommended dilution of water and detergent and solution temperature. |
| Ultrasonic | **CAUTION:** ULTRASONIC CLEANING CAN DAMAGE PLATING, BLACK OXIDE COATINGS, AND, IN ALUMINUM PARTS, DIMENSIONAL TOLERANCES. |
| | Put the parts into the ultrasonic cleaning tank using detergent Formula 815 GD or GD-NF and de-ionized water. Refer to the manufacturers specification for the recommended dilution of water and detergent and solution temperature. |
| | Let the parts to soak for 15 to 20 minutes maximum. |
| | Remove all evidence of dirt with a soft bristle brush or cleaning rag. |

Table 4002 - Cleaning Procedures

| Procedure | Instructions |
|---|---|
| Agitation | Put all parts into an agitation tank and clean using detergent Brulin 1990 GD and de-ionized water. Refer to the manufacturers specification for the recommended dilution of water and detergent and solution temperature. |
| | Agitate the parts until all evidence of dirt can be removed with a soft bristle brush or cleaning rag. |
| Soak | Put all parts into a soaking tank and clean using detergent Formula 815 GD or GD-NF or Brulin 1990 GD and de-ionized water. Refer to the manufacturers specification for the recommended dilution of water and detergent and solution temperature. |
| | Soak the parts until all evidence of dirt can be removed with a soft bristle brush or cleaning rag. |

Table 4002 - Cleaning Procedures (Continued)

**C. Rinse the parts.**

(1) Rinse the part(s) with de-ionized water.

**D. Do the applicable cleaning procedure again until the parts are clean and free of dirt and carbon residue.**

**E. Dry the parts.**

(1) Remove moisture that remains on the parts with a dry lint-free cloth.

**WARNING: WEAR INSULATED GLOVES AND OBSERVE ALL SAFETY PRECAUTIONS WHEN HANDLING HEATED PARTS TO AVOID PERSONAL INJURY.**

(2) Put the cleaned parts in an oven at a temperature of 200° to 250° F (93,3° to 121° C) for 2 to 3 hours.

**WARNING: ISOPROPYL ALCOHOL IS TOXIC AND FLAMMABLE. DO NOT USE NEAR OPEN FLAMES, WELDING AREAS, OR ON HOT SURFACES. INHALATION OF VAPORS CAN CAUSE DROWSINESS, DIZZINESS, AND HEADACHE. CONTACT WITH SKIN CAN CAUSE IRRITATION. USE IN A WELL-VENTILATED AREA**

(3) Examine each part for carbon particles by wiping with isopropyl alcohol on a clean lint-free cloth.

## 4. Corrosion Preventive

NOTE: If the drive shaft is not expected to be re-installed into a starter-generator immediately after cleaning, apply a corrosion preventive compound to its black oxide coating (identified by a very dark finish).

### A. Procedure

**WARNING: THE CORROSION PREVENTIVE COMPOUND IS FLAMMABLE AND TOXIC. EXTENDED EXPOSURE CAN CAUSE SKIN IRRITATION, DIZZINESS, AND HEADACHE. WHEN EXTENDED EXPOSURE IS NECESSARY, USE RESPIRATORY PROTECTION AND PROTECTIVE CLOTHING.**

(1) Apply a layer of MIL-C-16173, grade 3, corrosion preventive compound to the drive shaft.

NOTE: The drive shaft must be completely dry before you apply the corrosion preventive compound.

(2) Let the coating air dry for four hours. The coating will remain soft after drying.

## 5. Cleaning After Liquid Penetrant Inspection

### A. Description

This specifies the procedure for cleaning part(s) after liquid penetrant inspection. Cleaning is necessary to remove residual penetrant or developer that could cause interference in processing or service requirements. Rinse parts fully with water and fully dry to make sure there is no interference in processing or service requirements.

### B. Procedure

(1) Rinse the part(s) immediately after liquid penetrant inspection:

(a) The parts must be fully rinsed using water by manual or automated spray to remove the liquid penetrant.

1 Fully rinse the part(s) and aggressively agitate the part while it is immersed.

2 Pour the rinse water out from the part(s). Hold the part(s) vertical, open end down, for approximately one minute to drain.

(b) The part(s) surfaces must be visually examined under a black light after rinsing to make sure all the liquid penetrant has been removed.

1 Part(s) which show remaining liquid penetrant after rinsing must be fully cleaned and examined again.

(2) Drying of part(s) after rinsing:

**CAUTION:** REMAINING WATER USED FROM THE RINSING PROCEDURE MUST BE REMOVED. FAILURE TO OBEY DRYING INSTRUCTIONS CAN RESULT IN CORROSION OF THE MATERIAL.

(a) Remove the rinse water from the part(s) with a dry lint-free cloth.

**WARNING: WHEN YOU USE COMPRESSED AIR, ADJUST THE PRESSURE TO 29 PSI (200 KPA) MAXIMUM. PUT ON EYE PROTECTION TO PREVENT INJURY.**

**CAUTION:** MAKE SURE THAT COMPRESSED AIR FOR USE TO CLEAN/DRY THE COMPONENTS IS FREE FROM OIL AND WATER. THIS WILL PREVENT CONTAMINATION OF THE COMPONENTS.

(b) Use compressed air to remove rinse water.

**WARNING: FAILURE TO USE NECESSARY SAFETY PRECAUTIONS WHEN HANDLING HOT MATERIALS CAN CAUSE SEVERE BURNS TO SKIN. WEAR THERMAL PROTECTIVE CLOTHING WHEN HANDLING HEATED PARTS.**

(c) Immediately put the washed and rinsed part(s) in a vented 240° to 260° F (115,5° to 126,7° C) oven for a minimum of 2 hours.

1 The part(s) is to be positioned horizontally on a rack or on a block that will hold it in position.

(d) After the part(s) is fully dried and has cooled.

1 Check for indications of possible corrosion caused by the liquid penetrant.

a Reject the part(s) if corrosion is found.

2 If no corrosion is found, put the part(s) in a polyethylene bag with a bag of desiccant and seal it with tape, twist tie or rubber band.

3 The part(s) must be kept in a bag with desiccant until just before it is assembled on the starter-generator.

# CHECK

## 1. Introduction

This section provides initial and detailed component inspection procedures for starter-generators returning from service for scheduled and unscheduled maintenance. Complete an initial inspection of the starter-generator before beginning testing or disassembly. The results of this inspection will determine if a starter-generator is in satisfactory condition for a verification test or if it will need further disassembly, inspection, and/or replacement of parts.

This section provides the information that is needed to perform a satisfactory inspection of the starter-generator components. During an overhaul of the starter-generator, all primary components must be examined to determine if they are serviceable.

Reject a part if wear or damage is outside the acceptance limits or is not serviceable.

## 2. Necessary Tools and Materials

**WARNING: BEFORE USING ONE OF THE FOLLOWING MATERIALS, BE AWARE OF ALL HANDLING, STORAGE, AND DISPOSAL PRECAUTIONS RECOMMENDED BY THE MANUFACTURER OR SUPPLIER. FAILURE TO COMPLY WITH MANUFACTURER'S OR SUPPLIER'S RECOMMENDATIONS CAN RESULT IN SERIOUS INJURY, PHYSICAL DISORDER, OR DEATH.**

In addition to normal shop tools, specific tools and materials for inspection of the starter-generator are listed in Table 5001.

| Tool Description | Reference |
|---|---|
| Alcohol, Isopropyl | Table 4001 |
| Brush, non-metallic, soft bristle | Commercially Available |
| Cleaning pads/wiping cloths, lint-free, soft fabric | Commercially Available |
| Compression digital hand tester | Commercially Available |
| Dial Indicators | Commercially Available |
| Dynamic Balancer | Safran Power Standard Practice Document (SPD) 1001 |
| Growler | Commercially Available |
| Dielectric (Hi-Pot) Tester | Table 1002 |
| Magnifier, 7X to 10X | Commercially Available |
| Ohmmeter | Commercially Available |
| Surface Plate | Commercially Available |
| Pull Scale | Commercially Available |

Table 5001 - Inspection Tools and Materials

| Tool Description | Reference |
|---|---|
| V-blocks | Commercially Available |
| LCR Meter | Commercially Available |
| Dampener Plate Gauge Tool, P/N 19-601076 | Figure 9021 |

Table 5001 - Inspection Tools and Materials (Continued)

**A. Use of Growler**

A growler is required to check for shorted armature windings. When an alternating current is passed through a growler, the current sets up a magnetic flux in the windings of the armature. As the flux passes through the windings, a potential is induced causing current to flow if the winding is short-circuited. The current flow is then detected by an iron feeler, such as a hacksaw blade.

The most common way of using a growler is the 'feeler method' in which the growler spans a slot containing a winding. The feeler of iron is held about 0.25 inch (6,4 mm) above the slot containing the other side of the same winding. If the winding is shorted, the feeler will be pulled down to the slot and will stick and vibrate. The feeler can also be used on the same side of the winding that is spanned by the growler.

## 3. General Information

Check Acceptance Limit Measurements for individual components are found in the FITS AND CLEARANCES section of this CMM. If part does not meet acceptance limits, discard. Use the following procedures for all inspections.

**A. Examine the starter-generator and its components visually for:**

- signs of corrosion
- chipped-off enamel
- nicks, cracks, dents, scratches
- gouging, scoring or glazing mating surfaces
- fretting corrosion on mating surfaces
- loose or defective attaching parts
- distortion
- discoloration
- crossed or stripped threads
- condensation at drain holes
- torn or cracked seals

- galling or glazing of friction lining residue
- bent or distorted springs
- rounding, stripping or uneven wear on gear teeth

**B. Examine electrical components visually for:**

- loose or defective attaching parts
- damage caused by too much heat
- electrical arcing paths
- corroded contacts or terminals
- loose or defective electrical connector, contacts or terminals
- corroded electrical pins or connector
- bent connector pins
- loose, broken or shorted terminations

## 4. Initial Inspection

NOTE: If damage is found during inspection, stop the inspection immediately and begin further disassembly of the starter-generator using the instructions in the DISASSEMBLY section.

**A. Visually examine the starter-generator in a brightly lit work area in accordance with (IAW)** Paragraph 3.A.

(1) If shipping or handling damage exists, stop the inspection and notify your supervisor.

(2) If operational damage exists, write down the components that need to be replaced or repaired and continue the inspection.

**B. Clean the exterior of the starter-generator.**

**WARNING: ISOPROPYL ALCOHOL IS TOXIC AND FLAMMABLE; DO NOT USE NEAR OPEN FLAMES, WELDING AREAS, OR ON HOT SURFACES. INHALATION OF VAPORS CAN CAUSE DROWSINESS, DIZZINESS, AND HEADACHE. CONTACT WITH SKIN CAN CAUSE IRRITATION. USE IN A WELL-VENTILATED AREA.**

(1) Clean the surface of the starter-generator using a lint-free cleaning cloth moistened with isopropyl alcohol.

(2) If needed, loosen dust particles or grease with a soft bristle brush.

**C. Examine the starter-generator in a brightly lit work area IAW** Paragraph 3.B.

**D. Examine the installation between the housing and both end bells. Make sure that all attaching hardware is in place.**

## 5. Non-Destructive Test (NDT) Inspections

**A. Unless otherwise specified, do magnetic particle inspections IAW ASTM-E1444. Unless otherwise specified, acceptance criteria must be IAW MIL-STD-1907 Table 1, Grade A.**

**B. Unless otherwise specified, do liquid penetrant inspections IAW ASTM-E1417 type 1 Method A or B, sensitivity 2 or higher. Unless otherwise specified, acceptance criteria must be IAW MIL-STD-1907 Table II, Grade C.**

## 6. Replace Service Parts and Common Hardware

### A. Overhaul

During overhaul, replace the bearings, brushes and O-rings. Parts that have been removed during the disassembly, such as, insulating parts, retaining rings, screws, self-locking nuts and lock washers, must be discarded regardless of their condition. The screws that attach the brush leads to the brush holder do not need to be replaced unless damaged.

### B. Service repair

During repair, inspection or servicing, replace all exposed hardware and flat washers that are damaged, deformed, corroded, or have other apparent defects. Always replace bearings, retaining rings, lock washers, and self-locking nuts regardless of their condition if removed during disassembly.

## 7. Inspection Guidelines

### A. Repair or service inspection

Examine only those components that have been disassembled for repair or service. Do not disassemble components for inspection unless given instructions to do so in this section or in the TESTING AND FAULT ISOLATION section.

### B. The following terms are referenced in this section:

- DISCARD -

  If damage to the part is found or the part is outside of the acceptance limits in theFITS AND CLEARANCES section, the part must be removed and replaced with a new one.

- REPAIR -

  If damage to the part is found or the part is outside of the acceptance limits in the FITS AND CLEARANCES section, the part can be repaired by a procedure found in the REPAIR section.

- DISASSEMBLE -

  If damage to the part is found to a part in an assembly, or part of the assembly is outside of the acceptance limits in the FITS AND CLEARANCES section, you can disassemble the part from the assembly and repair or replace the damaged part(s).

- REPLACE -

  If damage occurs that causes a part to be outside of the acceptance limits in the FITS AND CLEARANCES section or there is no repair procedure for that part, replace the part. Retain the following parts to submit for remanufacture: armature and stator and housing assembly.

### C. Dimensions and Points

Letters (i.e., A,B,C,D, etc.) used in an illustration in this section indicate dimensions or points.

### D. Surfaces

Numbers (i.e., 1,2,3,4, etc.) used in an illustration indicate surfaces.

## 8. Inspection of Parts and Assemblies

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10001 of ILLUSTRATED PARTS LIST.

NOTE: In cases where a repair is authorized but the repair does not work, discard and replace the item in question regardless of whether or not it is so spelled out in this manual.

### A. V-Retainer coupling (10005-10) and T-bolt (10005-30).

(1) Examine V-retainer coupling (10005-10) IAW the procedures found in Paragraph 3.A.

  (a) DISCARD the part if damage or corrosion exists.

  (b) DISCARD the part if corroded or spot welds are damaged.

(2) Examine the T-bolt (10005-30) IAW the procedures found in Paragraph 3.A.

  (a) REPAIR the part if two or less threads are damaged.

  (b) DISCARD the part if more than two threads are damaged.

### B. Mounting adapter (10005-50). See Figure 5001.

(1) Examine mounting adapter (10005-50) IAW the procedures found in Paragraph 3.A.

  (a) DISCARD the part if cracks or major damage exists.

(b) REPAIR the part if minor surface damage exists.

(2) If the visual inspection finds indications which can be cracks, continue the inspection under 10X magnification.

(a) If visual indications of cracks or other structural defects are observed under 10X magnification, DISCARD the part.

(3) If the visual inspection under 10X magnification finds indications which can be cracks perform a liquid penetrant inspection IAW Paragraph 5.B.

NOTE: After liquid penetrant inspection, the part(s) must have the liquid penetrant removed to prevent interference with processing or with service requirements. Refer to the CLEANING section.

(a) REPLACE if damage is found.

(4) Examine mounting adapter (10005-50) for damaged or missing guide pin(s) (10005-60).

(a) REPLACE pin(s) (10005-60) if damage exists or they are not within limits of the FITS AND CLEARANCES section.

(5) Inspect the seal assembly for any loose or missing drive screws and washers. Replace as necessary.

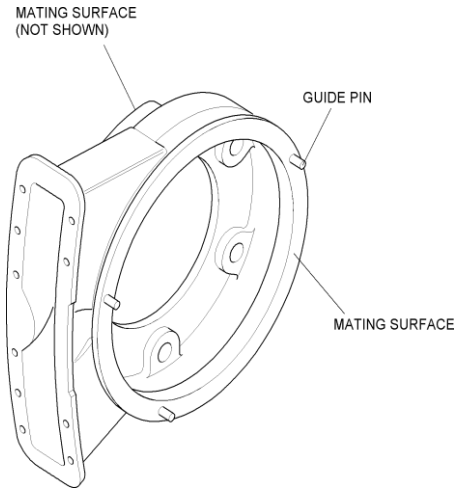


Figure 5001 - Mounting Adapter

**C. Identification plate (10). See Figure 5002.**

NOTE: ID plates with superficial nicks, dents and scratches, that do not interfere with the legibility of the identification nameplate, can be reused providing they are sealed with acrylic coating.

(1) Examine the part IAW the procedures found in Paragraph 3.A.

If damage exists or the information is faded or unreadable:

(a) Retain the original identification plate.

(b) Transfer the information from the original identification plate to a replacement identification plate (10).

(c) DISCARD the original identification plate.

(2) Make sure that the drive screws (20) are tight and in place.

(a) DISCARD loose drive screws (20).

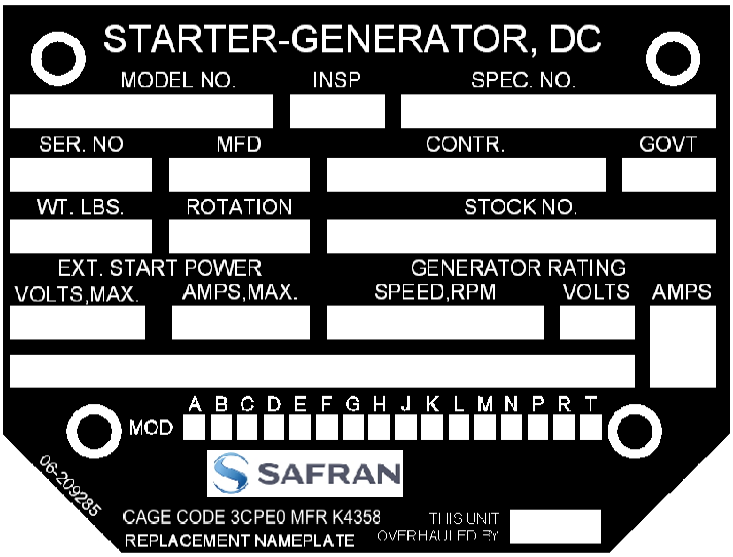


Figure 5002 - Typical Replacement Identification Plate

**D. Terminal block cover (80).**

(1) Examine the part IAW the procedures found in Paragraph 3.A.

(2) DISCARD the part if damage exists.

**E. Air inlet (100). See Figure 5003.**

(1) Examine the part IAW the procedures found in Paragraph 3.A.

(2) DISCARD the part if cracks, major damage or fretting corrosion on either the inlet or mounting flange exists.

(3) REPAIR the part if minor surface damage exists.

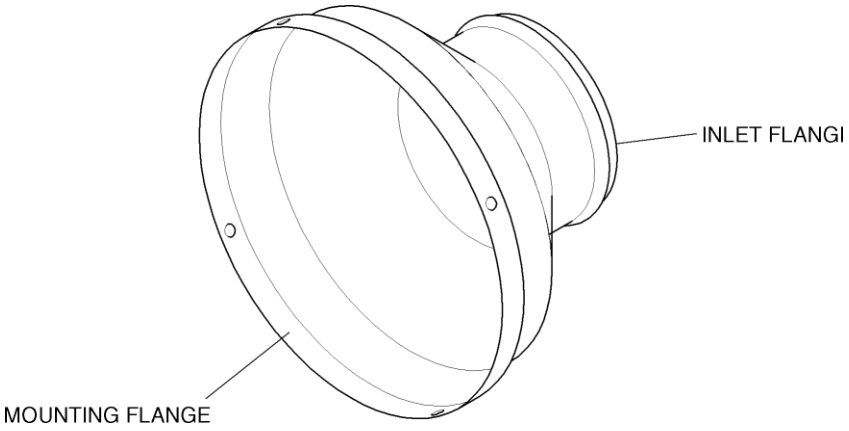


Figure 5003 - Air Inlet

**F. Fan Shroud (130). See** Figure 5004**.**

(1) Examine the part IAW the procedures found in Paragraph 3.A.

(2) DISCARD the part if cracks, major damage or fretting corrosion on either the inlet or mounting flange exists.

(3) REPAIR the part if minor surface damage exists.

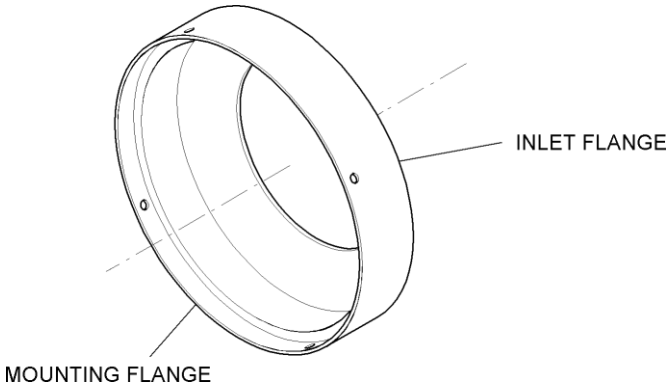


Figure 5004 - Fan Shroud

**G. Brush access cover (160). See Figure 5005.**

(1) Examine the part IAW the procedures found in Paragraph 3.A.

(a) DISCARD the part if cracks or major damage exists.

(b) REPAIR the part if minor surface damage exists.

(2) Examine the insulating tape for tears or loose edges.

(a) REPAIR the insulating tape if it is loose or worn.

(3) Examine the screw (170) threads IAW the procedures found in Paragraph 3.A.

(a) REPAIR the part if two or less threads are damaged.

(b) DISCARD the part if more than two threads are damaged.

(4) Make sure that the blind rivet nut (180) on the bracket is tightly attached.

(a) REPAIR the part if the nut is loose or missing.

(5) Examine the blind rivet nut (180) threads IAW the procedures found in Paragraph 3.A.

(a) REPAIR the part if two or less threads are damaged.

(b) DISCARD the part if more than two threads are damaged.

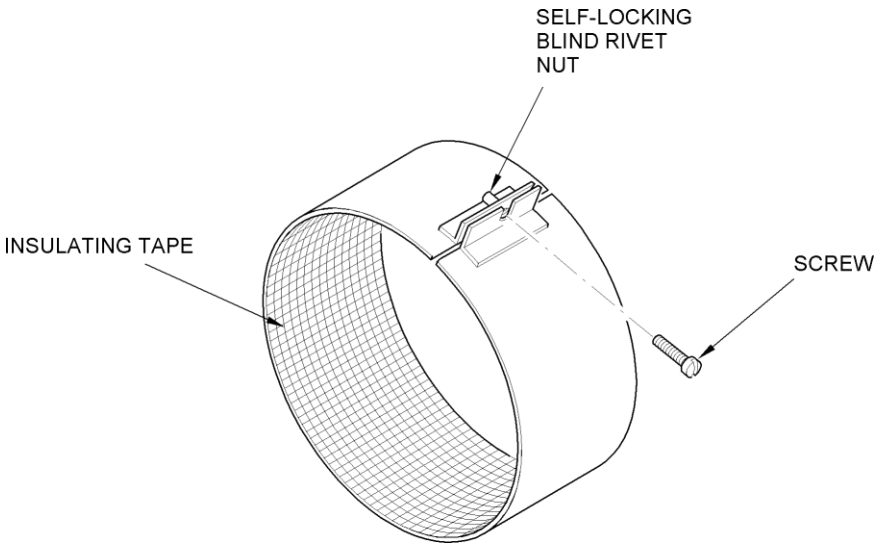


Figure 5005 - Brush Access Cover

**H. Brushes (190). See** Figure 5006**.**

NOTE: For repair only. Brushes must be replaced at each overhaul.

(1) Visually examine brushes for cracks, chips, frayed leads, and loose rivets or loose connections.

(a) DISCARD brushes if damaged.

(2) Visually examine wear indicator for remaining allowable wear.

(a) REPLACE brushes if remaining allowable wear will be exceeded before the next overhaul. Seat new brushes in accordance with instructions in SPD 1006.

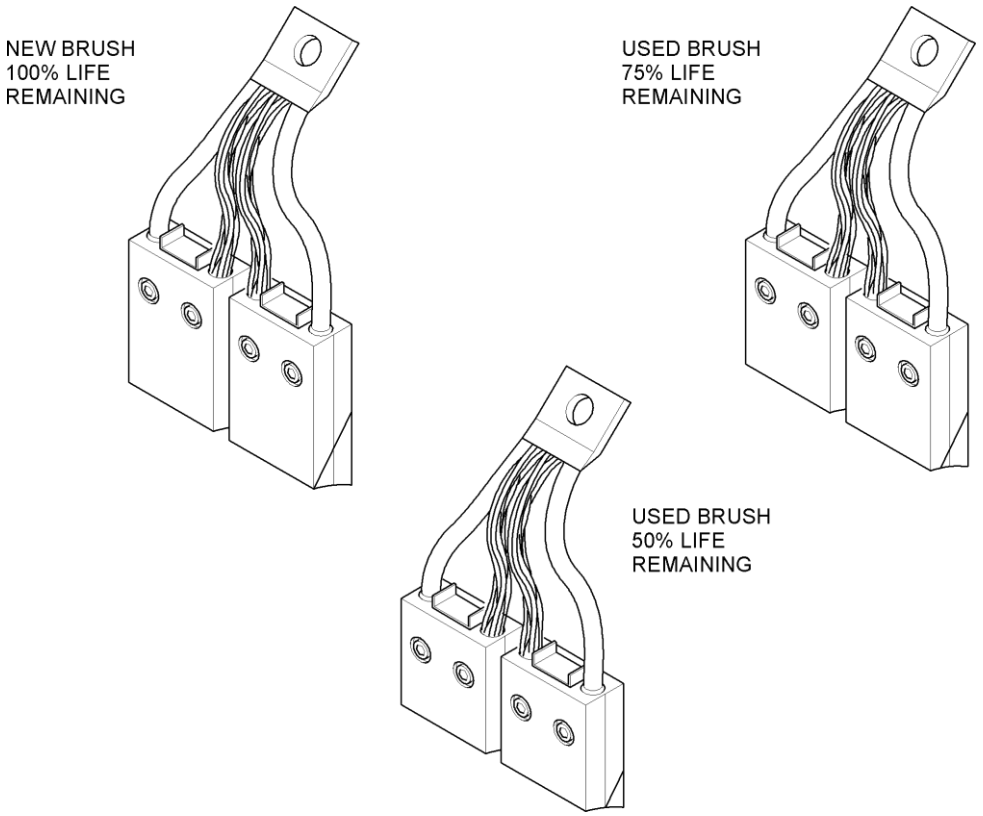


Figure 5006 - Brush Wear

**I. Fan (210). See** Figure 5007**.**

(1) Examine the part IAW the procedures found in Paragraph 3.A.

NOTE: Pay particular attention to the blade edges and surfaces and shaft mating surface.

(a) DISCARD the part if cracks, scoring-gouging-glazing on mating surfaces, or major damage exists.

(b) REPAIR the fan if minor surface damage is found.

(2) If the visual inspection finds indications which can be cracks, continue the inspection under 10X magnification.

(a) If visual indications of cracks or other structural defects are observed under 10X magnification, DISCARD the part.

(3) If the visual inspection under 10X magnification finds indications which can be cracks perform a liquid penetrant inspection IAW Paragraph 5.B.

NOTE: After liquid penetrant inspection, the part(s) must have the liquid penetrant removed to prevent interference with processing or with service requirements. Refer to the CLEANING section.

(a) REPLACE if damage is found.

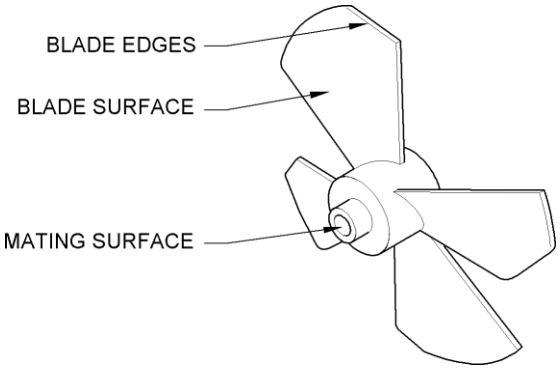


Figure 5007 - Fan

**J. Drive shaft (240) and dampener hub (280). See Figure 5008.**

(1) Examine the part IAW the procedures found in Paragraph 3.A.

(a) DISASSEMBLE the drive shaft (240) and dampener hub (280) if cracks or thread damage beyond two threads exist.

(b) REPAIR the drive shaft (240) and dampener hub (280) if dents, nicks and scratches exist.

(2) Examine armature mating spline, drive spline, and dampener hub spline for rounding, stripping, or uneven wear.

(a) DISASSEMBLE drive shaft (240) and dampener hub (280) if damaged.

(b) DISCARD the damaged part.

(3) Measure the drive spline diameter over two gage pins.

(a) DISASSEMBLE the drive shaft (240) and dampener hub (280) if the diameter is not within the limits in the FITS AND CLEARANCES section.

(b) DISCARD the out of specification part.

(4) Perform a magnetic particle inspection IAW procedures found in Paragraph 5.A.

(a) DISCARD the drive shaft (240) and dampener hub (280) if damage is found.

NOTE: Examine drive shaft and dampener hub mating surfaces only if dampener hub was removed from drive shaft.

(5) Visually examine mating surfaces for gouging, scoring, or glazing.

(a) REPAIR damaged surface(s) if minor damage is found.

(b) DISCARD part(s) if part(s) fail visual inspection.

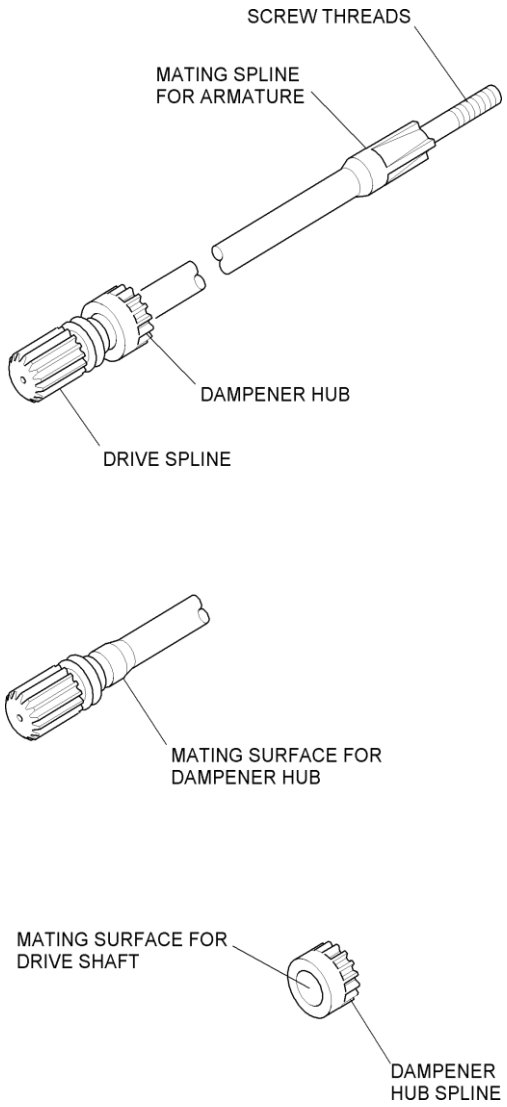


Figure 5008 - Drive Shaft and Dampener Hub.

**K. Friction ring (260). See Figure 5009.**

**WARNING: DO NOT CUT, RIP, OR SAND ASBESTOS-CONTAINING MATERIALS. LEAVE UNDAMAGED MATERIALS ALONE AND, TO THE EXTENT POSSIBLE, PREVENT THEM FROM BEING DAMAGED, DISTURBED, OR TOUCHED. DISCARD MATERIAL BY FIRST CHECKING WITH LOCAL HEALTH, ENVIRONMENTAL, OR OTHER APPROPRIATE OFFICIALS TO FIND OUT ABOUT PROPER HANDLING AND DISPOSAL PROCEDURES.**

(1) If friction ring is Part No. 02-5600-05, it must be discarded because it contains asbestos.

(2) Examine the part IAW the procedures found in Paragraph 3.A.

(a) DISCARD the part if damage is found.

(3) Measure the friction ring (260) thickness.

(a) DISCARD the part if thickness is not within limits in the FITS AND CLEARANCES section.

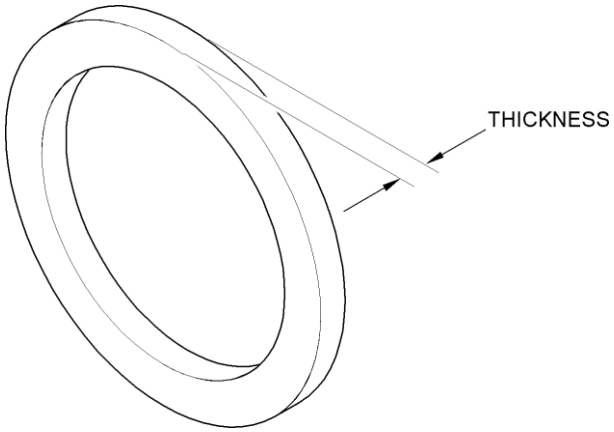


Figure 5009 - Friction Ring

**L. Dampener plate (270). See Figure 5010.**

(1) Examine the part IAW the procedures found in Paragraph 3.A.

(a) DISCARD the part if cracks exist.

(b) REPAIR if minor nicks, scratches, gouging, scoring, or glazing is found.

(2) Examine the spline teeth for rounding, stripping, or uneven wear.

(a) DISCARD the part if damaged.

(3) Measure the dampener plate (270) thickness.

(a) DISCARD if thickness is below the acceptance limit in the FITS AND CLEARANCES section.

(4) Use the dampener plate gauge (19-601076) (See Figure 9021) to check the splines of the dampener plate (270), or measure the distance between pins of the spline teeth.

(a) The dampener plate (270) is acceptable if the plate has a tight fit on the dampener plate gauge or does not fit.

(b) The dampener plate must be discarded if the plate fits easily on the dampener plate gauge or is loose.

(c) If measuring the distance between spline teeth, DISCARD if distance is above the acceptance limit in the FITS AND CLEARANCES section.

(5) Perform a magnetic particle inspection IAW the procedures found in Paragraph 5.A.

(a) DISCARD the part if damaged.

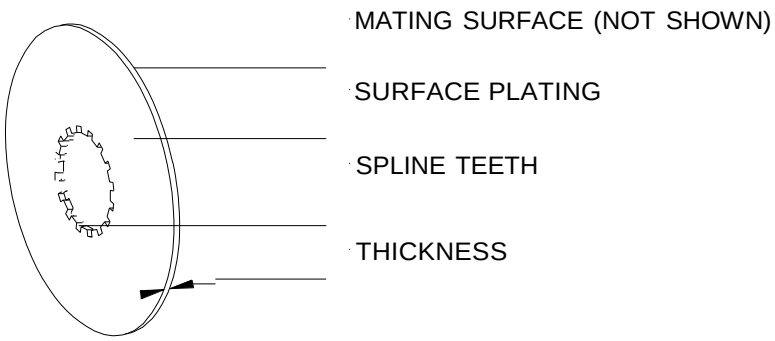


Figure 5010 - Dampener Plate

**M. Dampener back plate (290). See Figure 5011.**

(1) Examine the part IAW the procedures found in Paragraph 3.A.

(a) DISCARD the part if cracks exist.

(b) REPAIR if minor nicks or scratches exist.

(c) DISCARD if gouging, scoring, or glazing exists on mating surfaces.

(2) Perform a magnetic particle inspection IAW the procedures found in Paragraph 5.A.

(a) DISCARD if damage is found.

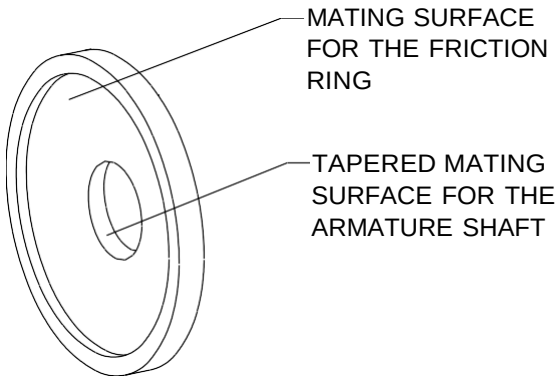


Figure 5011 - Dampener Back Plate

**N. Speed pickup spur gear (310). See Figure 5012.**

(1) Examine the part IAW the procedures found in Paragraph 3.A.

(a) DISCARD the part if cracks are found.

(b) REPAIR if minor nicks, dents or scratches are found.

(2) Visually examine mating surfaces for gouging, scoring or glazing.

(a) DISCARD the part if damaged.

(3) Visually examine teeth for wear (contact with magnetic speed pickup).

(a) DISCARD the part if damaged.

(4) Perform magnetic particle inspection IAW the procedures found in Paragraph 5.A.

(a) DISCARD the part if damaged.

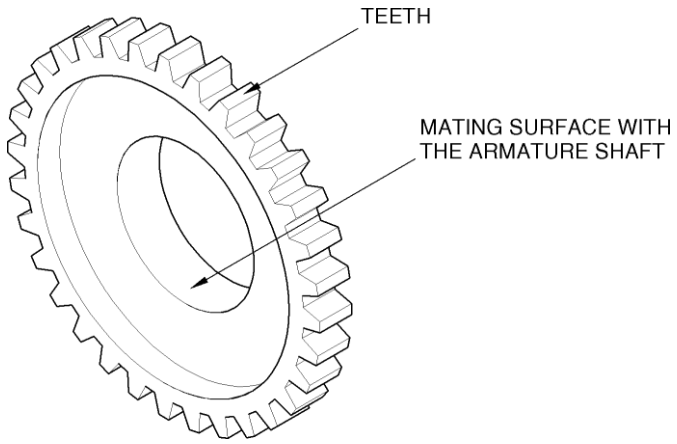


Figure 5012 - Speed Pickup Gear

**O. Bearing and brush support assembly (320). See Figure 5013 through Figure 5014.**

(1) Examine the part IAW the procedures found in Paragraph 3.A.

NOTE: Refer to service bulletin “SB 23080-360-24-01” for the conversion to anti-drive end end bell P/N 23080-3055. This service bulletin specifies the repair of anti-drive end (ADE) end bells that have small crack(s) in the thin wall area between the bearing retainer screw hole and the bearing liner

(a) DISCARD the part if cracks or fretting and/or corrosion on the mating surface are found.

(b) REPAIR if minor dents, scratches and nicks or gouging scoring or glazing on the mating surfaces (marked 1, 2, 3, and 6 on Figure 5013) are found.

(2) If the visual inspection finds indications which can be cracks, continue the inspection under 10X magnification.

(a) If visual indications of cracks or other structural defects are observed under 10X magnification, DISCARD the part.

(3) If the visual inspection under 10X magnification finds indications which can be cracks perform a liquid penetrant inspection IAW section 5.B.

NOTE: After liquid penetrant inspection, the part(s) must have the liquid penetrant removed to prevent interference with processing or with service requirements. Refer to the CLEANING section.

(a) REPLACE if damage is found.

(4) Measure bearing liner diameter “A.” Using a gage with an accuracy of ± 0.00004 inch (0,0010 mm). See Figure 5013.

(a) DISASSEMBLE the bearing and brush support assembly (320) if damage exists.

(b) REPAIR if bearing liner diameter does not meet the limits in the FITS AND CLEARANCES section.

(5) Examine the helicoil inserts (10002-20) (marked 4 and 5 on Figure 5013) for damage.

(a) REPAIR helicoil if damage is found.

(b) REPAIR damaged parts.

(6) Hand tighten a machine screw into the blind rivet nut in each complete brush holder (10002-30) to assure that the self-locking feature is functional. The machine screw should bind in the blind rivet nut before it is fully engaged.

(a) REPAIR the complete brush holder (10002-30) if the blind rivet nut is damaged.

(b) REPAIR the complete brush holder (10002-30) if the self-locking feature does not function properly.

(7) Examine the brush holders (10002-40), including the brush spring supports and center supports for cracks, warping, and discoloration caused by electrical arcing.

(a) DISCARD the complete brush holder (10002-30) if damage exists.

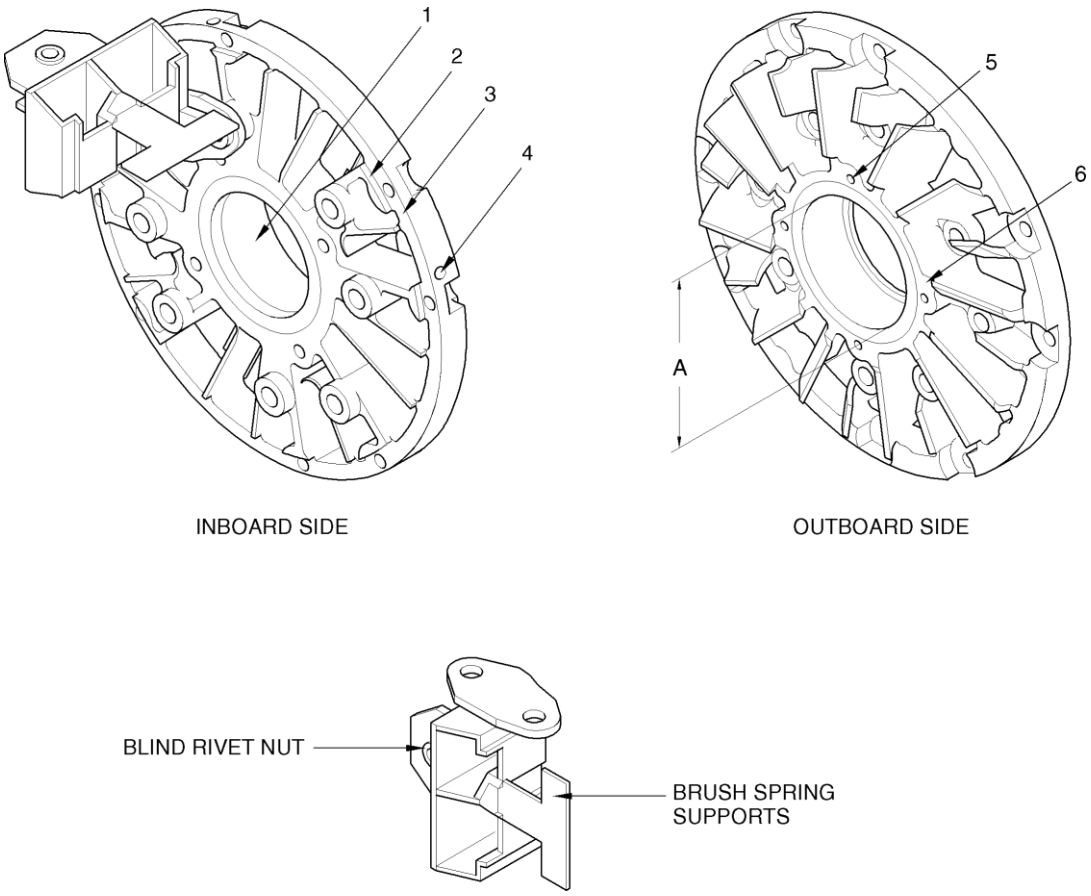


Figure 5013 - Bearing and Brush Support Assembly, Inboard and Outboard Side

(8) Measure brush spring (10002-130) force using pull scale with harness. See Figure 5014.

NOTE: When measuring brush spring force, readings can vary widely depending on where measuring device touches spring. Measurements must be taken from curved tip of spring at point where spring touches brush.

(a) Take six measurements.

(b) Calculate an average from the measurements.

(c) Discard brush spring if not within limits of FITS AND CLEARANCES.

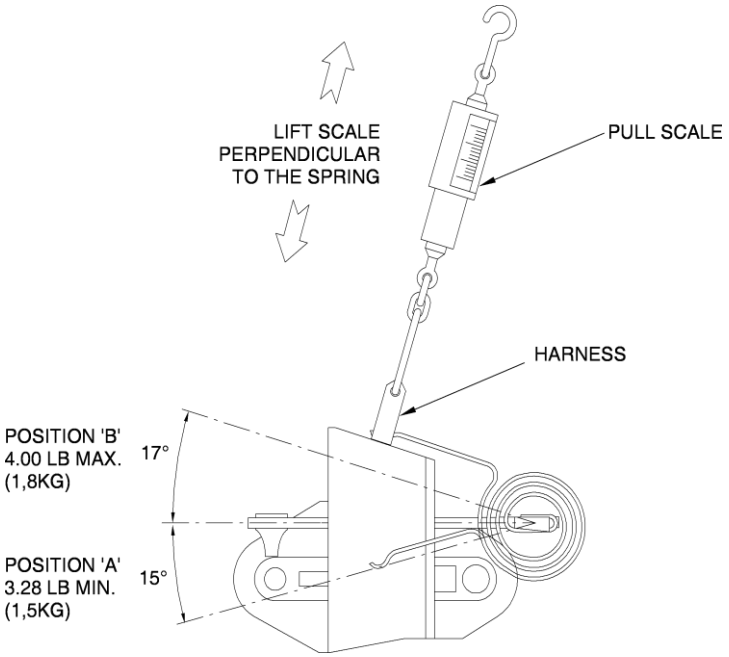


Figure 5014 - Determine Spring Force

(9) Perform a dielectric test.

**WARNING:** **BEFORE YOU USE THE HIGH VOLTAGE ELECTRICAL EQUIPMENT, MAKE SURE THAT THE POWER SWITCH IS IN THE 'OFF' POSITION. MAKE SURE THAT NO PERSON TOUCHES THE EQUIPMENT OR THE PROBES. THIS WILL PREVENT DEATH OR INJURY FROM ELECTRIC SHOCK.**

**CAUTION:** FAILURE TO TURN OFF HIGH POTENTIAL TESTER POWER BEFORE CONNECTING OR DISCONNECTING HIGH VOLTAGE ELECTRICAL LEADS CAN CAUSE SERIOUS DAMAGE TO BEARING AND BRUSH SUPPORT ASSEMBLY.

**CAUTION:** BEARING AND BRUSH SUPPORT ASSEMBLY (320) MUST BE THOROUGHLY CLEAN BEFORE PERFORMING A DIELECTRIC CHECK.

(a) With power OFF, connect positive test lead of high potential tester to metal surface of brush holder.

(b) With power OFF, connect negative test lead to uncoated surface of bearing and brush support.

(c) With high potential tester output voltage at 0, turn power ON.Slowly adjust output voltage (at a rate not more than 100 V/sec.) to 250 V RMS, commercial frequency. Adjust voltage back to 0.

(d) Turn high potential tester power OFF.

(e) Disconnect test leads from bearing and brush support assembly.

(f) Acceptance Limits:

1 Arcing as evidenced by flashover (surface discharge), spark over (air discharge), breakdown (puncture discharge), or leakage current that is more than 2 mA is evidence of damp, dirty, weak or defective components and constitutes a failure.

If bearing and brush support assembly (320) fails dielectric test, clean bearing and brush support assembly, and repeat dielectric test.

2 If bearing and brush support assembly fails dielectric test after cleaning, disassemble bearing and brush support assembly, replace all insulating materials (i.e., washers, sleeves, plates), and repeat dielectric test.

If bearing and brush support assembly (320) fails dielectric test, replace bearing and brush support assembly.

**P. Baffle disc, spacer or bearing shield (350). See** Figure 5015**.**

(1) Examine the part IAW the procedures found in Paragraph 3.A.

(a) DISCARD the part if damaged.

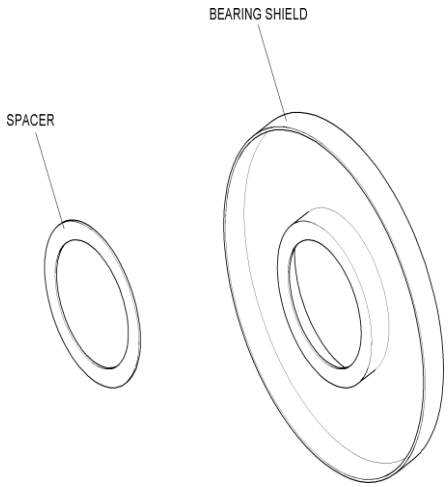


Figure 5015 - acer and Bearing Shield

**Q. Connector (360) and spacer (370).**

(1) Examine the part IAW the procedures found in Paragraph 3.A. and Paragraph 3.B.

(2) Make sure that connector (360) pins are not bent or missing.

(3) DISCARD the connector (360) and/or spacer (370) if damage exists.

**R. Thermal switch (390). See Figure 5016.**

(1) Examine the part IAW the procedures found in Paragraph 3.A.

(2) REPLACE thermal switch (390) if damaged.

(3) Examine insulation sleeving for cracks or tears.

(a) REPLACE thermal switch (390) if damaged.

(4) Use an ohmmeter to check for continuity of switch at ambient air temperature.

(a) REPLACE thermal switch (390) if continuity is indicated.

**WARNING: USE NECESSARY PRECAUTIONS WHEN HANDLING HEATED PARTS TO AVOID INJURY TO PERSONNEL.**

(5) Use an oven to heat thermal switch assembly to 340° F (171° C).

(6) Use an ohmmeter to check for continuity of assembly.

(a) REPLACE thermal switch (390) if continuity is not less than 0.1 Λ.

NOTE: Thermal switch is a normally open switch with an operating range of 300° to 350° F (149° to 177° C). The switch closes when temperature rises to 322 to 338° F (161,1 to 170° C) and opens when temperature drops to 292 to 308° F (144,4 to 153,3° C).

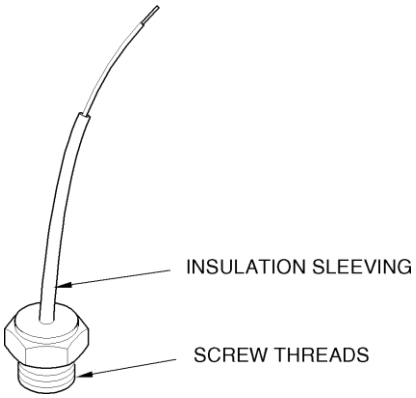


Figure 5016 - Thermal Switch

**S. Drive end bearing support assembly (400). See Figure 5017.**

(1) Examine the part IAW the procedures found in Paragraph 3.A.

(a) DISCARD the part if cracks or fretting and/or corrosion on the mating surface are found.

(b) REPAIR if minor dents, scratches and nicks or gouging, scoring or glazing on the mating surfaces are found.

(2) If the visual inspection finds indications which can be cracks, continue the inspection under 10X magnification.

(a) If visual indications of cracks or other structural defects are observed under 10X magnification, DISCARD the part.

(3) If the visual inspection under 10X magnification finds indications which can be cracks, perform a liquid penetrant inspection IAW Paragraph 5.B.

NOTE: After liquid penetrant inspection, the part(s) must have the liquid penetrant removed to prevent interference with processing or with service requirements. Refer to the CLEANING section.

(a) REPLACE if damage is found.

(4) Measure bearing liner diameter “A” using a gage with an accuracy of ± 0.00004 inch (0,0010 mm). See Figure 5017.

(a) REPAIR the bearing liner if the measurements are not within the limits of the FITS AND CLEARANCES section.

(5) Examine the threaded hole (marked 1 on Figure 5017) for crossed or stripped threads.

(a) DISCARD drive end bearing support assembly (400) if threaded hole damaged.

(6) Examine screen (10003-20) for tears.

(a) DISASSEMBLE drive end bearing support assembly (400) if damage is found.

(b) DISCARD drive screws (10003-30) and damaged screen (10003-20).

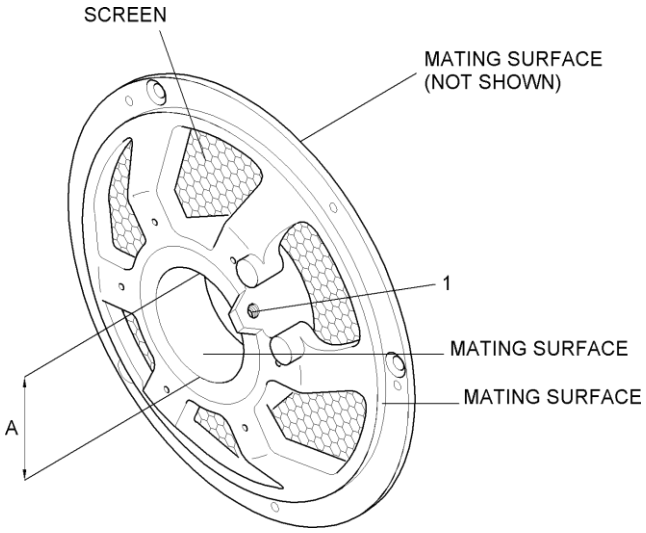


Figure 5017 - Drive End Bearing Support Assembly

**T. Speed pickup (420). See** Figure 5018**.**

(1) Examine the part IAW the procedures found in Paragraph 3.A.

(a) REPAIR the part if two or less threads are damaged.

(b) DISCARD the part if more than two threads are damaged or other damage exists.

(2) Examine the insulation sleeving for damage.

(a) DISCARD the part if damage exists.

(3) Measure resistance between each speed pickup lead and ground. REPLACE the speed pickup if it does not meet the limit in FITS AND CLEARANCES section.

(4) Measure resistance between the two speed pickup leads. REPLACE the speed pickup if the resistance is not within the limits in FITS AND CLEARANCES section.

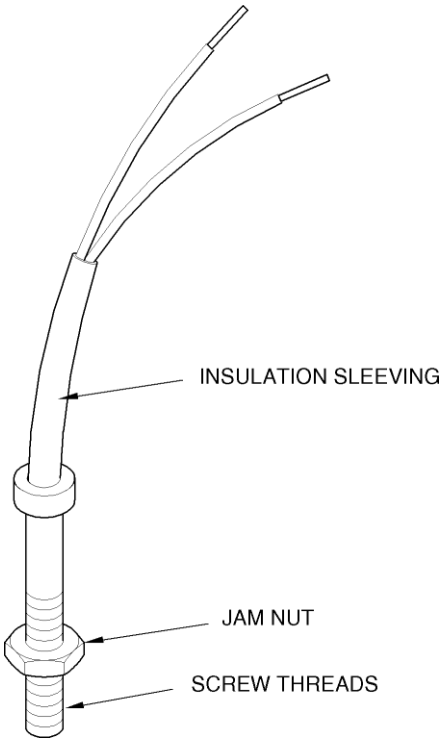


Figure 5018 - Speed Pickup

**U. Spring wave washer (460). See Figure 5019.**

(1) Examine the part IAW the procedures found in Paragraph 3.A.

(2) DISCARD the spring wave washer (460) if damage is found.

(3) Use a Compression Digital Hand Tester, or equivalent, to measure the force required to compress the spring from the free height ($H_F$) to the compressed height ($H_C$). See Figure 5019.

(a) DISCARD if the load given in Table 5002 is not met.

| Free Height ($H_F$) | Compressed Height ($H_C$) | Acceptance Limits |
|---|---|---|
| 0.125 inch (3,18 mm) | 0.062 inch (1,58 mm) | 26 to 34 lbs. (11,8 to 15,4 kg) |

Table 5002 - Spring Wave Washer Inspection

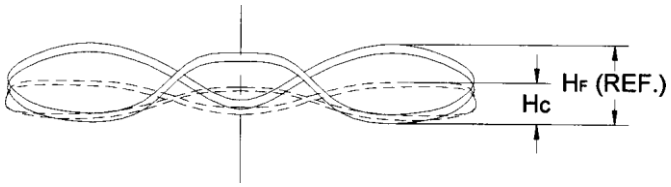


Figure 5019 - Spring Wave Washer Load Inspection

**V. Armature (500). See** Figure 5020**.**

**CAUTION:** INSULATING ENAMEL (GLYPTAL OR EQUIVALENT) IS NOT APPROVED ON THE ARMATURE WINDINGS. THE ARMATURE MUST BE REPLACED IF YOU FIND INSULATING ENAMEL (GLYPTAL OR EQUIVALENT) ON THE ARMATURE WINDINGS.

(1) Before the commutator is refinished, measure commutator bar-to-bar run-out in a full circumference outside the brush paths (area where the brushes do not touch).

(a) REPLACE armature (500) if bar-to-bar run-out is more than the limits of the FITS AND CLEARANCES section before refinishing the armature. NO REPAIR IS PERMITTED.

(2) Examine the part IAW the procedures found in Paragraph 3.A.

(a) DISCARD the part if cracks or fretting and/or corrosion on the mating surface are found.

(b) REPAIR if minor dents, scratches and nicks or gouging scoring or glazing on the mating surfaces are found.

(3) Examine the armature for insulating enamel (Glyptal or equivalent).

(a) REPLACE the armature if insulating enamel (Glyptal or equivalent) is found on the armature windings.

(4) Examine bearing journals for gouging, scoring, or glazing.

(a) REPAIR bearing journals if damaged.

(b) REPLACE armature if damage is not repairable.

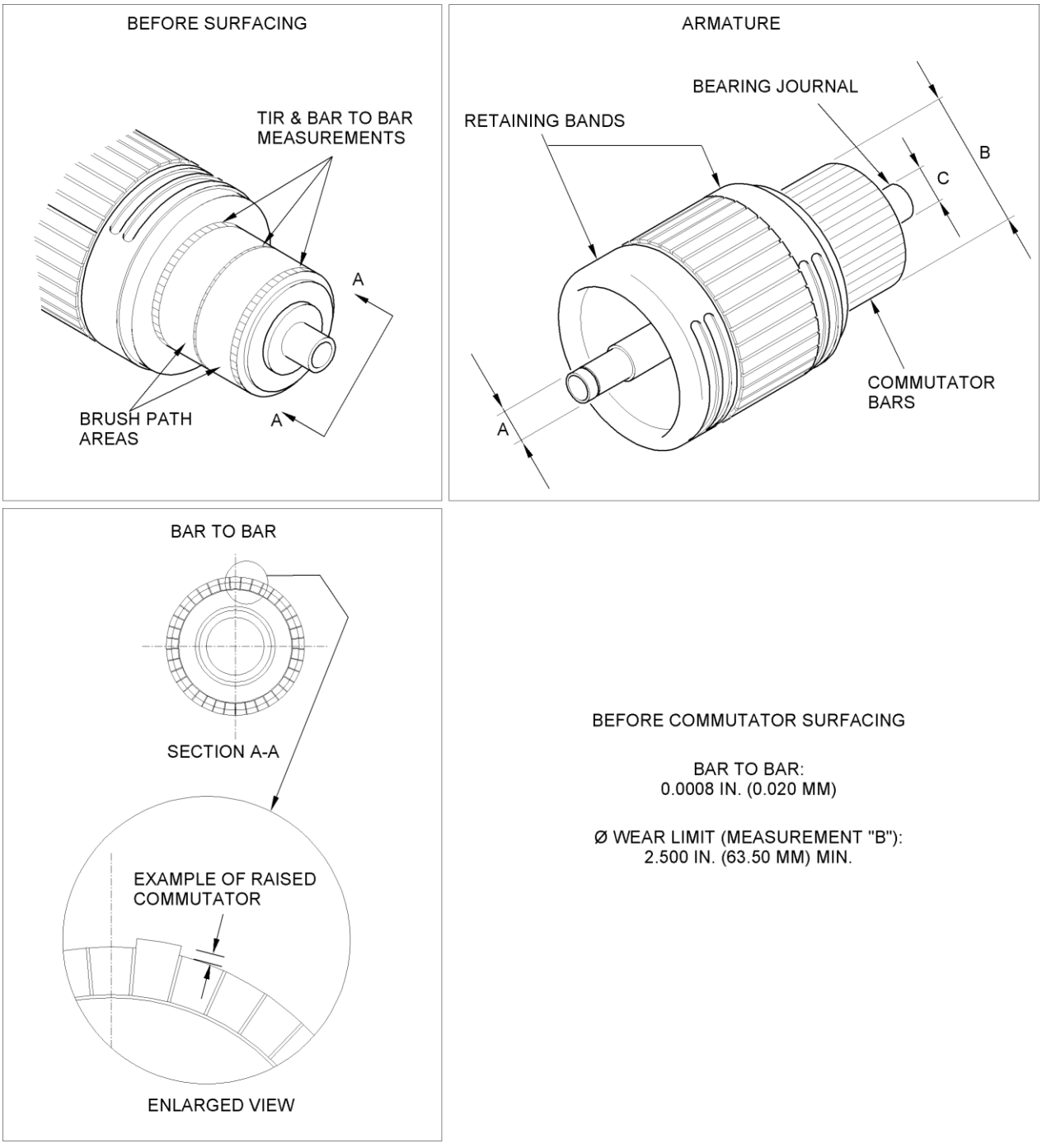


Figure 5020 - Armature Check

(5) Measure bearing journal diameters, A and C, as shown in Figure 5020.

(a) REPAIR bearing journals if they do not meet limits in FITS AND CLEARANCES section. Refer to SPD 1000.

(b) REPLACE armature if damage is not repairable.

(6) Measure commutator diameter B, as shown in Figure 5020.

(a) REPLACE armature if minimum commutator diameter “B” is below limit in FITS AND CLEARANCES section.

(7) Examine internal spline for rounding, stripping, or uneven wear.

(a) Check the drive spline for too much wear by engaging a new drive shaft into the armature internal drive spline. Reject the armature shaft if too much play is found when engaging the drive shaft.

NOTE: An armature spline with too much wear will not engage tightly with a new drive shaft.

(b) Use a bright light to visually examine the internal spline of the armature shaft for gouging or rounding of the spline. Reject the part if damage is found.

NOTE: The armature shaft internal spline cannot be repaired. The armature shaft cannot be removed from the armature for replacement in the field.

(c) REPLACE armature if damaged.

(8) Examine commutator undercut for broken, damaged or missing mica.

(a) REPLACE armature if damaged.

(9) Examine commutator bars for burning and discoloration.

(a) REPAIR commutator if damaged.

(b) REPLACE armature if damage is not repairable.

(10) Measure commutator undercut.

(a) REPAIR commutator if mica undercut depth (before recut) is below limits in FITS AND CLEARANCES section.

(b) REPLACE armature if damage is not repairable.

(11) Test armature windings for shorts using a growler and iron feeler. Refer to Paragraph 2.A. of this section for additional information about use of growler during inspection.

(a) REPLACE the armature (500) if a short exists.

(12) Perform a dielectric test.

**WARNING:** **BEFORE YOU OPERATE THE HIGH-VOLTAGE TESTER, MAKE SURE THAT THE POWER SWITCH IS IN THE 'OFF' POSITION. MAKE SURE THAT NO PERSON TOUCHES THEEQUIPMENT OR THE PROBES. THESE PRECAUTIONS PREVENT POSSIBLE DEATH OR INJURY FROM ELECTRIC SHOCK.**

**CAUTION:** YOU CAN CAUSE SERIOUS DAMAGE TO THE ARMATURE IF YOU DO NOT TURN OFF THE HIGH POTENTIAL TESTER BEFORE YOU CONNECT THE HIGH VOLTAGE ELECTRICAL LEADS.

**CAUTION:** ARMATURE (500) MUST BE THOROUGHLY CLEAN BEFORE PERFORMING A DIELECTRIC TEST.

(a) Set the power to the OFF position. Connect the positive test lead of the high potential tester to a commutator.

(b) Set the power to the OFF position. Put the negative test lead on the armature shaft.

(c) Set the high potential tester output voltage to 0. Turn the power to the ON position.

**CAUTION:** INCREASE AND DECREASE TEST VOLTAGES SLOWLY (100 VOLTS PER SECOND, MAXIMUM). IF THE VOLTAGE IS INCREASED AND/OR DECREASED TOO QUICKLY IT CAN CAUSE DAMAGE TO THE ARMATURE.

(d) At a rate that is not more than 100 V/sec., slowly adjust the output voltage to 250 V RMS, commercial frequency for 1 minute. Slowly decrease the voltage back to 0.

(e) Turn high potential tester power to the OFF position.

(f) Remove negative test lead.

(g) Keep the positive test lead connected to the commutator.

(h) Connect the negative lead to the drive end retaining band.

(i) Do the dielectric test again between the retaining band and commutator.

(j) Turn high potential tester power to the OFF position.

(k) Remove negative test lead.

(l) Keep the positive test lead connected to the commutator.

(m) Connect the negative lead to the anti-drive end retaining band.

(n) Do the dielectric test again between retaining band and commutator.

(o) Turn high potential tester power to the OFF position.

(p) Disconnect all test leads.

(q) Acceptance Limits:

1 Arcing as evidenced by flashover (surface discharge), spark over (air discharge), breakdown (puncture discharge), or leakage current that is more than 2mA is evidence of damp, dirty, weak or defective components and constitutes a failure.

If armature (500) fails dielectric test, clean armature and repeat dielectric test.

2 If armature (500) fails dielectric test after cleaning, replace armature.

**W. Bearing retainer (510). See** Figure 5021**.**

(1) Examine the part IAW the procedures found in Paragraph 3.A.

(a) DISCARD the part if damaged.

(2) Carefully examine mating surfaces 1 and 2 for gouging, scoring or glazing.

(a) DISCARD the part if damaged.

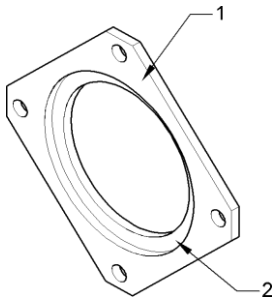


Figure 5021 - Bearing Retainer

**X. Stator and housing assembly (540). See Figure 5022.**

**CAUTION:** INSULATING ENAMEL (GLYPTAL OR EQUIVALENT) IS NOT APPROVED ON THE STATOR WINDINGS. THE STATOR MUST BE REPLACED IF YOU FIND INSULATING ENAMEL (GLYPTAL OR EQUIVALENT) ON THE STATOR WINDINGS.

(1) Examine the part IAW the procedures found in Paragraph 3.A. and Paragraph 3.B.

(a) DISCARD the part if cracks or other major damage exists.

(b) REPAIR thread damage of two turns or less.

(c) DISCARD the part if thread damage is more than two turns.

(d) REPAIR the part if other damage exists.

(2) Examine the stator for insulating enamel (Glyptal or equivalent).

(a) REPLACE the stator if insulating enamel (Glyptal or equivalent) is found on the stator windings.

(3) Examine the brush leads and stator leads for damage.

(a) If brush lead damage is more than 5 percent of the brush lead, REPLACE the stator and housing assembly (540).

(b) If stator lead damage is found, REPLACE the stator and housing assembly (540).

(4) Perform a dielectric test.

**WARNING:** **BEFORE YOU USE THE HIGH VOLTAGE ELECTRICAL EQUIPMENT, MAKE SURE THAT THE POWER SWITCH IS IN THE 'OFF' POSITION. MAKE SURE THAT NO PERSON TOUCHES THE EQUIPMENT OR THE PROBES. THIS WILL PREVENT DEATH OR INJURY FROM ELECTRIC SHOCK.**

**CAUTION:** FAILURE TO TURN OFF THE HIGH POTENTIAL TESTER POWER BEFORE CONNECTING OR DISCONNECTING HIGH VOLTAGE ELECTRICAL LEADS CAN CAUSE SERIOUS DAMAGE TO THE STATOR AND HOUSING ASSEMBLY.

**CAUTION:** STATOR AND HOUSING ASSEMBLY (540) MUST BE THOROUGHLY CLEAN BEFORE PERFORMING A DIELECTRIC CHECK.

(a) Jumper all stator leads together.

(b) With power OFF, connect positive test lead of high potential tester to jumpered stator leads.

(c) With power OFF, connect negative test lead to uncoated surface of housing.

(d) With high potential tester output voltage at 0, turn power ON.

(e) At a rate not to be more than 100 V/sec., slowly adjust output voltage to 250 V RMS, commercial frequency for one minute. Slowly decrease voltage back to 0.

(f) Turn high potential tester power OFF.

(g) Disconnect test leads.

(h) Disconnect jumper from stator leads.

(i) Acceptance Limits:

1 Arcing as evidenced by flashover (surface discharge), spark over (air discharge), breakdown (puncture discharge), or leakage current that is more than 2 mA is evidence of damp, dirty, weak or defective components and constitutes a failure.

If stator and housing assembly (540) fails dielectric test, clean stator and housing assembly and repeat dielectric test.

2 If stator and housing assembly (540) fails dielectric test after cleaning, replace stator and housing assembly.

(5) Use an ohmmeter to check for continuity between terminals A and E.

(a) REPLACE the stator and housing assembly (540) if an open circuit exists.

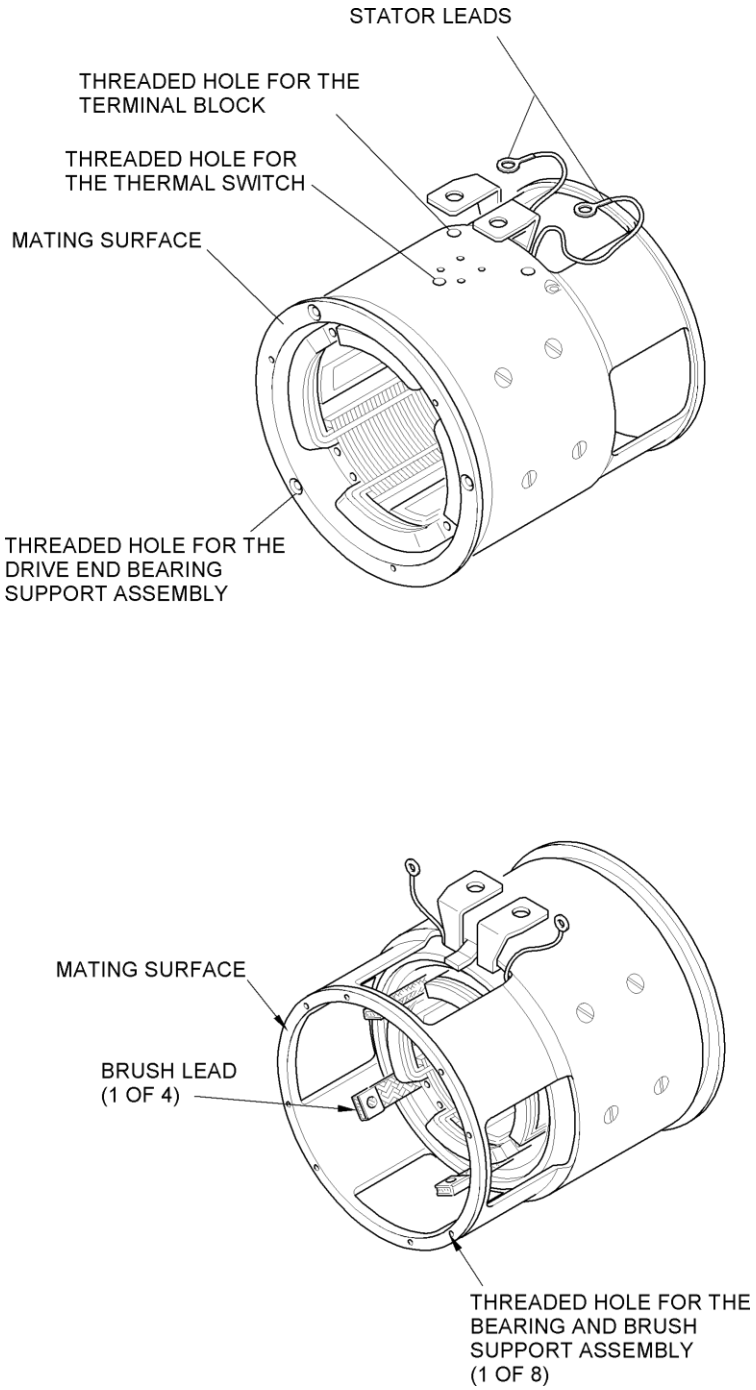


Figure 5022 - Stator and Housing Assembly

**Y. Anti-drive end bearing shield (550). See** Figure 5023**.**

(1) Examine the part IAW the procedures found in Paragraph 3.A.

(a) DISCARD the part if damaged.

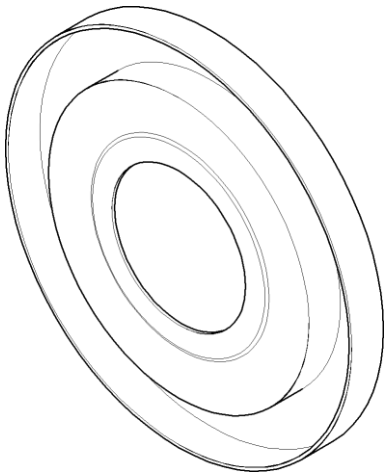

Figure 5023 - Anti-Drive End Bearing Shield

**Z. Terminal block (10004-80). See** Figure 5024**.**

**CAUTION:** THE USE OF RE-MANUFACTURED TERMINAL BLOCKS IS NOT AUTHORIZED BY SAFRAN POWER. DAMAGED TERMINAL BLOCKS (OTHER THAN THOSE WITH REPAIRABLE THREAD DAMAGE) MUST BE DISCARDED.

(1) Examine the part IAW the procedures found in Paragraph 3.A.

(a) DISCARD the part if damage, other than thread damage, exists.

(b) REPAIR the part if thread damage of two turns or less exists.

(c) For model 23080-056, DISCARD the terminal block (10004-80) if thread damage of more than two turns exists.

(d) For all other models, REPLACE the terminal block stud(s), terminals B and E (10004-50) if thread damage of more than two turns exists. Refer to REPAIR.

(2) Using an LCR (inductance, capacitance and resistance) meter, measure the capacitance values as shown.

(a) Measure the capacitance values between B and E at the frequency shown in the FITS AND CLEARANCES section.

1 DISCARD the part if capacitance values fall outside the required limits in the FITS AND CLEARANCES section.

(b) Measure the capacitance values between terminal B and ground lead at the frequency shown in the FITS AND CLEARANCES section.

1 DISCARD the part if capacitance values fall outside the required limits in the FITS AND CLEARANCES section.

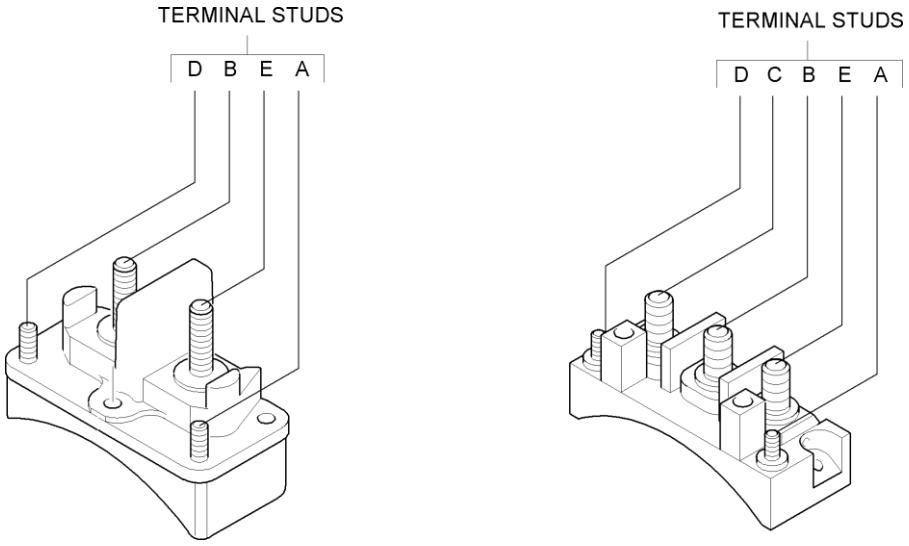


Figure 5024 - Terminal Block

## 9. Terminology

Table 5003 lists the definitions of terms used to describe damage conditions.

| Term | Definition | Probable Cause |
|---|---|---|
| Corrosion | The chemical or electrochemical reaction between a material, usually a metal, and its environment that produces a deterioration of the material and its properties. | Environmental condition that causes deterioration. |
| Crack | A break in material. | Severe stress from overload or shock; possible extension of a scratch. |
| Dent | A small, smoothly rounded depression. | A sharp blow or too much pressure. |
| Fretting | Wear that occurs between tight-fitting surfaces subjected to cyclical relative motion of extremely small amplitude. Usually, fretting is accompanied by corrosion, especially of the very fine wear debris. | Vibration between mating surfaces. |
| Fretting corrosion | The accelerated deterioration at the interface between contacting surfaces as the result of corrosion and slight oscillatory movement between the two surfaces. | Vibration between mating surfaces. |
| Galling | Transfer of metal from one surface to another. | Result of localized lubrication break-down between sliding surfaces. |
| Glazing | Smoothing and creep of a surface. | Result of localized lubrication break-down between sliding surfaces. |
| Gouging | Removal of surface material, typified by rough and deep depressions. | Protruding objects, incorrectly aligned. |
| Nick | A sharp bottomed depression that can have rough outer edges. | Dropping, banging. |
| Rounding | Removal of surface metal at corners or dulling of edges. | Result of abrasion, vibration, or poor mating surfaces. |
| Scoring | A deep scratch following a path of part travel. | Result of localized lubrication break-down between sliding surfaces. |

Table 5003 - Terminology

| Term | Definition | Probable Cause |
|---|---|---|
| Scratch | A very shallow furrow or irregularity, usually longer than wide. | Movement of a sharp object across the surface. |
| Short | Evidenced by sparking, arcing, or high current. Electrical condition where two conductors are connected by a path of very low resistance. | The result when two carrying conductors are connected by a path of negligible resistance. |
| Stripped Thread | Thread of a nut, stud, bolt, or screw damaged by tearing away parts of the thread. | Incorrect installation of threaded mating parts. |
| Tear | Parting of material. | Too much tension, caused by external force. |
| Wear | Slow removal of material. Wear may not be visible to the naked eye. | Result of abrasive substances contacting rolling surfaces and acting as a lapping compound. |

Table 5003 - Terminology (Continued)

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# REPAIR

## 1. Introduction

**CAUTION:** USE OF PARTS, MATERIALS, OR PROCESSES NOT AUTHORIZED BY SAFRAN POWER FOR MAINTENANCE OR OVERHAUL OF THE STARTER-GENERATOR CAN AFFECT CONTINUED FLIGHT WORTHINESS OR INVALIDATE CERTIFICATION.

Repairs are limited to:

- repairing damaged surfaces
- repairing damaged threads
- replacing helicoil inserts
- bearing liner and journal restoration
- commutator refinishing
- armature balancing
- restoring surface coatings of parts and assemblies
- correcting output voltage polarity
- replacing brush access cover insulating tape
- replacing brush access cover self-locking blind rivet nut
- repair and replacement of QAD mounting adapter guide pins
- replacing QAD seal.

Repair operations not outlined or referenced in this manual are not authorized by Safran Power.

In addition to specific repairs authorized by Safran Power in this manual, standard repair procedures for starter-generators are described in the following Safran Power Standard Practice Documents (SPD).

- Selective (Brush Plating), Electrodeposition - Refer to SPD 1000.
- Armature Balancing for DC Starter-Generators - Refer to SPD 1001.
- Surface Repair and Coating - Refer to SPD 1002.
- Plastic Media Blasting - Refer to SPD 1003.
- Brush Holder Alignment Fixtures - Refer to SPD 1004.
- Brush Installation, Seating, and Run-In - Refer to SPD 1006.

## 2. Repair Tools

In addition to normal shop tools, specific tools for repair of the starter-generator are listed in Table 6001.

NOTE: Equivalent substitutes can be used for the tools listed in Table 6001.

| Tools | Reference |
|---|---|
| Bump Switch | Rating: 30 VDC, 10 A |
| Commutator Turning Fixture | Figure 9008 |
| Crimp Tool | Commercially Available |
| Drive End Inboard Hub Support | Figure 9015 |
| Drive End Outboard Hub Support | Figure 9015 |
| Helicoil Insert Removal and Installation Tool | Commercially Available |
| India Stone | Commercially Available |
| PlusNut® Fastener Header<br>P/N C1000-1032 | Figure 9020 |
| Rivet Alignment and Press Fixture | Figure 9009 |
| 6 V Battery or Equivalent DC Power Source | Commercially Available |
| Stud Installer, Mustang No. 1 | Titan Tool Company, inc.<br>7410 West Ridge road<br>Fairview, PA 16415<br>Ph: (814) 474-1583<br>Fax: (814) 474-5337<br>www.titantoolco.com |
| Terminal Stud Remover<br>P/N: E23824-SQ5<br><br>Extracto©<br>Stud Remover<br>3/8 inch-24<br>Equipped with 1/2 inch drive | |
| Terminal Stud Driver<br>P/N: M1-AQ5-08<br><br>Mustang©<br>Stud Driver<br>3/8 inch-24<br>Equipped with 1/2 inch drive | |
| Thread Chasers | Commercially Available |

Table 6001 - Repair Tools

## 3. Repair Materials

Materials necessary for starter-generator repair are listed in Table 6002.

NOTE: Repair materials are not available from Safran Power. All items can be purchased commercially.

**WARNING: BEFORE USING ANY OF THE FOLLOWING MATERIALS, BE AWARE OF ALL HANDLING, STORAGE AND DISPOSAL PRECAUTIONS RECOMMENDED BY THE MANUFACTURER OR SUPPLIER. FAILURE TO COMPLY WITH THE RECOMMENDATIONS MAY RESULT IN SERIOUS INJURY, PHYSICAL DISORDER, OR DEATH.**

| Item | Description/Material Specification | Source |
|---|---|---|
| Chemical Film Solution Alodine 1200 | Chemical Film Solution MIL-C-5541, Class 1A or Class 3 | Henkel Surface Technology Madison Heights, MI 48071 www.henkel.ca (V1N6B3) |
| Coating, Zinc Phosphate | TT-C-490, Type 1 | Commercially Available |
| Isopropyl Alcohol | TT-I-735, Grade A<br><br>See **WARNING** before using this material.<br><br>Flash Point: 53° F (12° C), FLAMMABLE<br><br>Refer to the Material Safety Data (MSD) Sheet for the material for additional safety information | Commercially Available |
| Oil, Machine | N/A | Commercially Available |
| Pads, Cleaning | Lint-free cotton | Commercially available |
| Primer, Zinc Chromate | TT-P-1757 Composition G, Color Yellow. | Commercially Available |
| Abrasive paper | 400/600 grit (non-aluminum oxide only) | Commercially Available |
| Tape, Insulating | P/N SG13-06R 8 mil, PTFE coated fiberglass, acrylic adhesive | Saint Gobain New Haven, CT www.saint-gobain.com/us (V1DS07) |

Table 6002 - Repair Materials

| Item | Description/Material Specification | Source |
|---|---|---|
| Silicone Adhesive | RTV 732 White | Dow Corning Corporation<br>P O Box 994<br>Midland, MI<br>48686-0994<br>www.dowcorning.com<br>(V71984) |
| Cotton swab | N/A | Commercially Available |
| Thread Locking Primer | Primer, Loctite Grade 7649 | Loctite Corporation<br>Aurora, IL<br>Ph: (860) 571-5100<br>www.loctite.com (V7V827)<br>or<br>Commercially Available |
| Thread Locking Adhesive | Loctite Grade 243 | |

Table 6002 - Repair Materials (Continued)

## 4. Surface Repair

Repair corroded or damaged surfaces of parts that have qualified for repair according to the CHECK section inspection guidelines.

### A. Repair Procedure

(1) Remove corrosion, sharp edges, burrs, nicks, or scratches from cast surfaces, machined mating surfaces, and sealing surfaces with india stone or abrasive paper. Remove only sharp edges or burrs that are above surface of part.

(2) Remove minor raised edges, burrs, nicks, or scratches on polished or load-bearing surface. Remove only material that extends above polished surface. Make sure that dimensional tolerances are within limits

## 5. Thread Repair

### A. Repair damaged threads as follows:

**CAUTION:** DO NOT USE THREAD CUTTING DIE, NON-REPAIRABLE DAMAGE CAN RESULT.

(1) Use thread chaser to repair damaged threads.

(2) Use india stone to remove remaining sharp edges or burrs.

(3) To prevent corrosion apply a light coating of machine oil to repaired threads.

## 6. Helicoil Insert Replacement

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10002 of ILLUSTRATED PARTS LIST.

**A. Remove and replace damaged helicoil inserts (20) as needed.**

(1) Remove damaged helicoil insert with a helicoil insertion/removal tool.

(2) Clean hole for helicoil insert. Refer to the CLEANING section.

**WARNING: PRIMER CAN BE DANGEROUS TO PERSONS. USE ONLY IN AN AREA WITH A GOOD FLOW OF AIR. KEEP AWAY FROM SOURCES OF IGNITION. DO NOT BREATHE THE FUMES. PREVENT SKIN CONTACT. PUT ON PROTECTIVE CLOTHING AND EYE PROTECTION. IF NECESSARY, PUT ON A RESPIRATOR.**

**WARNING: KEEP ZINC CHROMATE PRIMER AWAY FROM SOURCES OF HEAT, SPARKS AND FLAME. ZINC CHROMATE PRIMER IS FLAMMABLE.**

**WARNING: DO NOT GET ZINC CHROMATE PRIMER ON YOUR SKIN AND DO NOT BREATHE THE FUMES. ZINC CHROMATE PRIMER IS A POISONOUS MATERIAL.**

(3) Apply thin coat of zinc chromate primer to outer surface of replacement helicoil insert.

(4) Install helicoil insert to the depth shown in Figure 6001 below part surface while primer is still wet.

(5) Break off helicoil insert installation tang.

**WARNING: KEEP CHEMICAL FILM AWAY FROM SOURCES OF HEAT, SPARKS AND FLAME. CHEMICAL FILM IS FLAMMABLE.**

**WARNING: DO NOT GET CHEMICAL FILM ON YOUR SKIN AND DO NOT BREATHE THE FUMES. CHEMICAL FILM IS A POISONOUS MATERIAL.**

(6) Apply chemical film solution MIL-C-5541, Class 3 to bare metal.

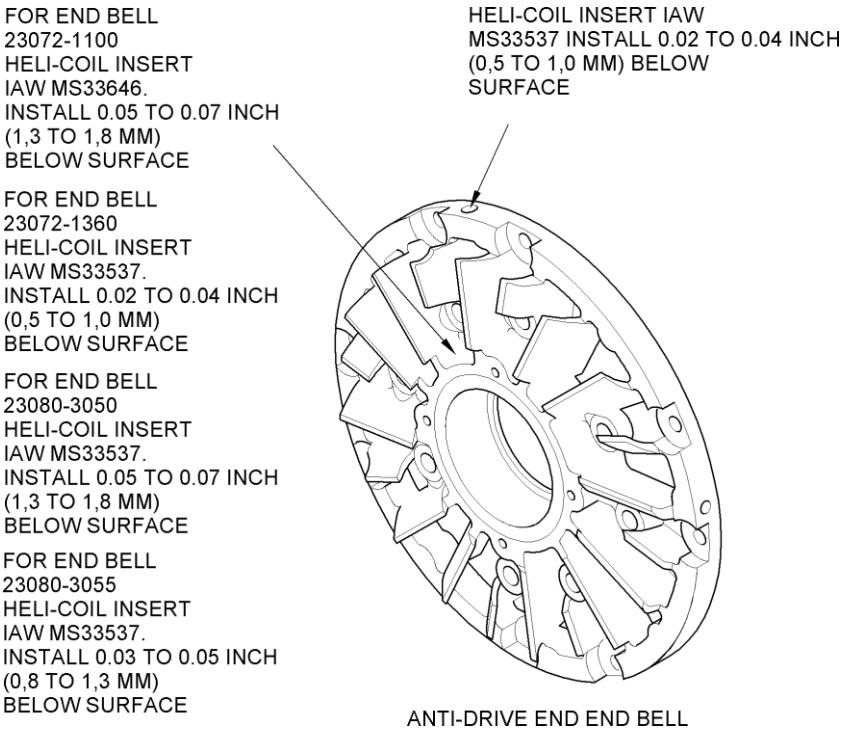



Figure 6001 - Helicoil Insert Replacement

## 7. Bearing Journal and Liner Restoration

If bearing journals or liners are worn beyond acceptance limits, restoration can still be possible. Refer to SPD 1000 for repair limitations and procedures for Nickel Plating.

NOTE: To modify the drive end end bell to bearing pre-load configuration refer to Service Bulletin 23291-XXX-24-07.

### A. Restoration

Refer to SPD 1000 for detailed instructions. Components not in compliance with the dimensions in Figure 6002, Figure 6003 and Figure 6004 must be reworked, or replaced.

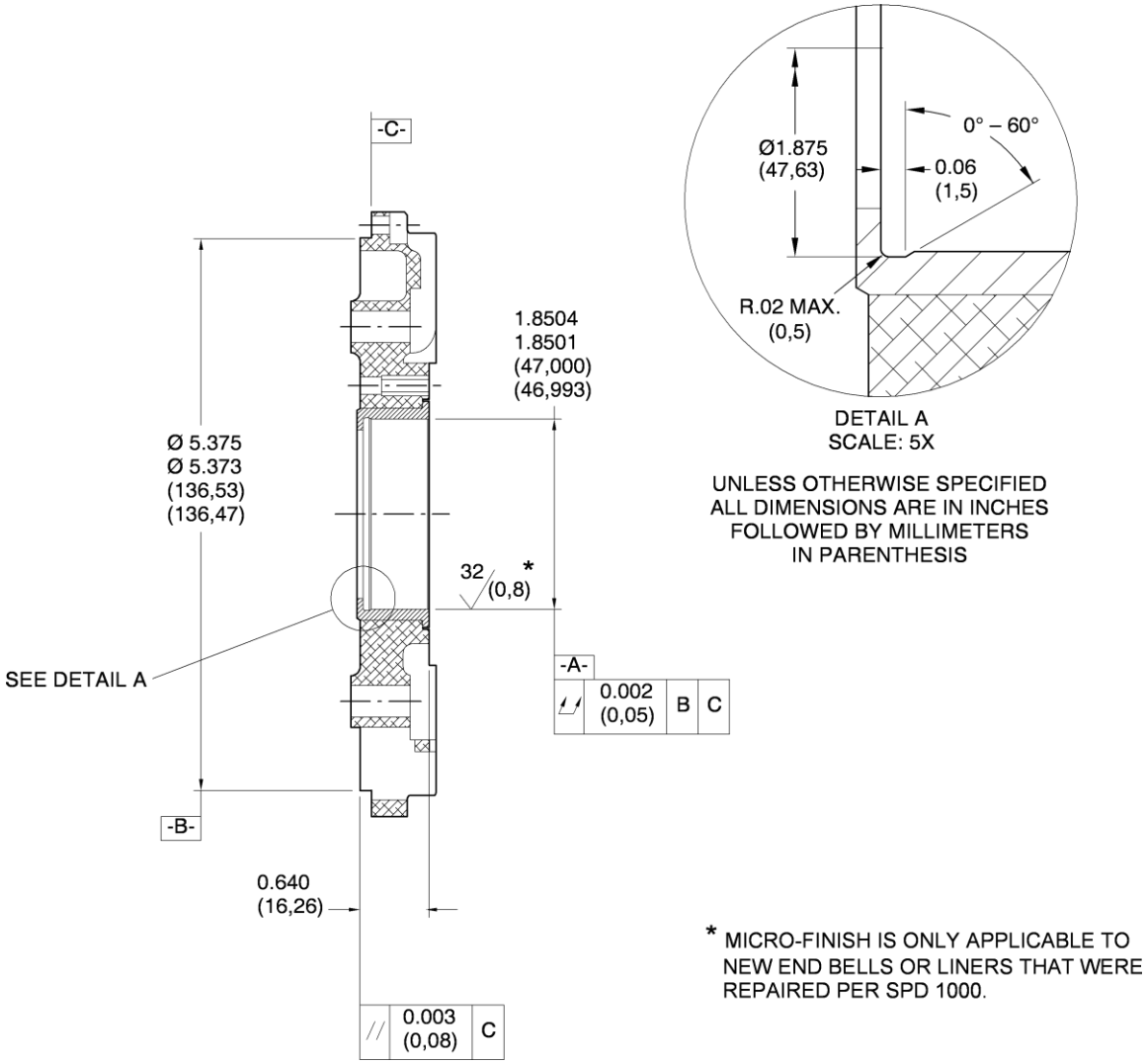



Figure 6002 - Anti-Drive End End Bell Bearing Liner Machining Specifications

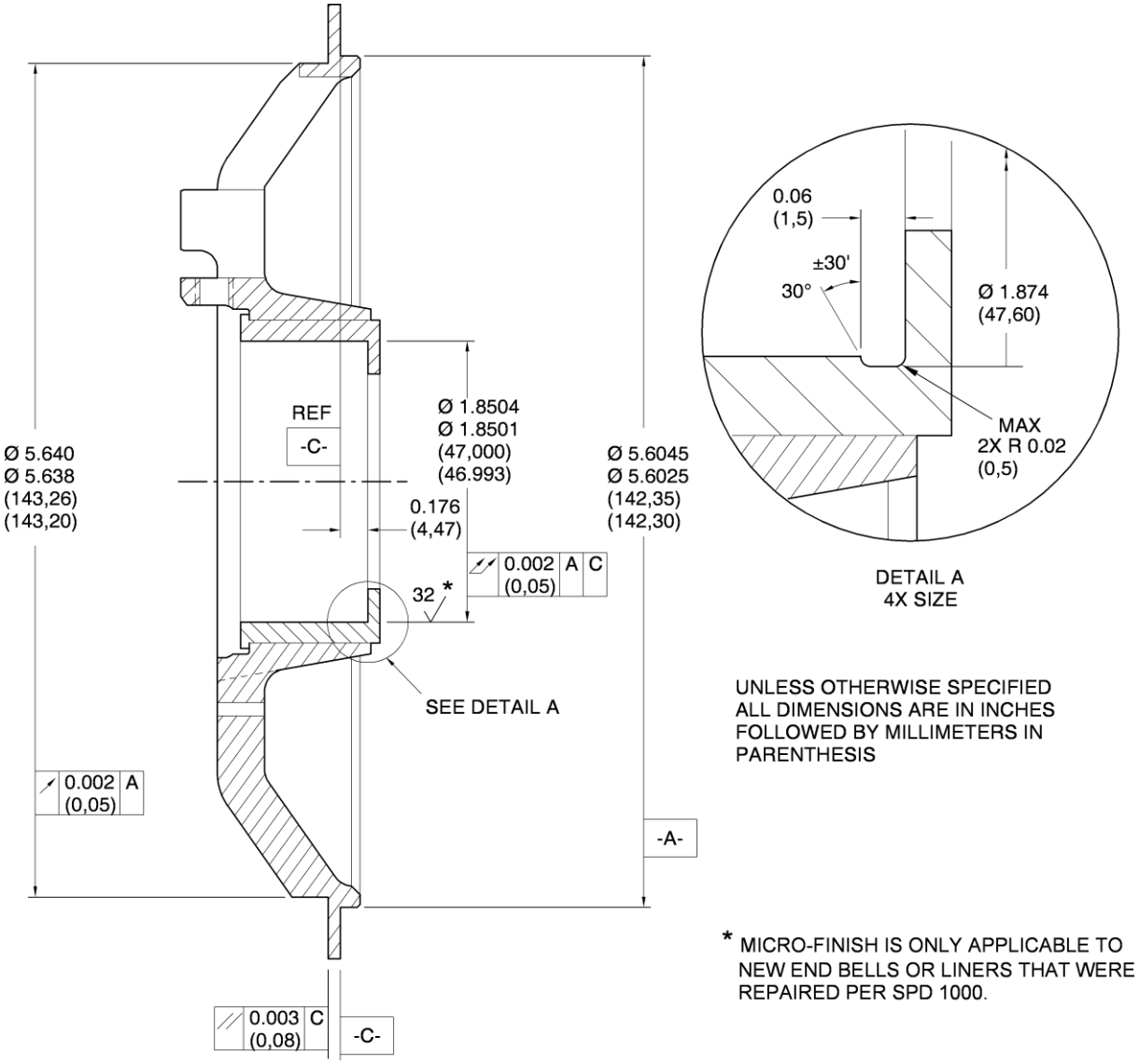



Figure 6003 - Drive End End Bell Bearing Liner Machining Specifications (Pre-Load)

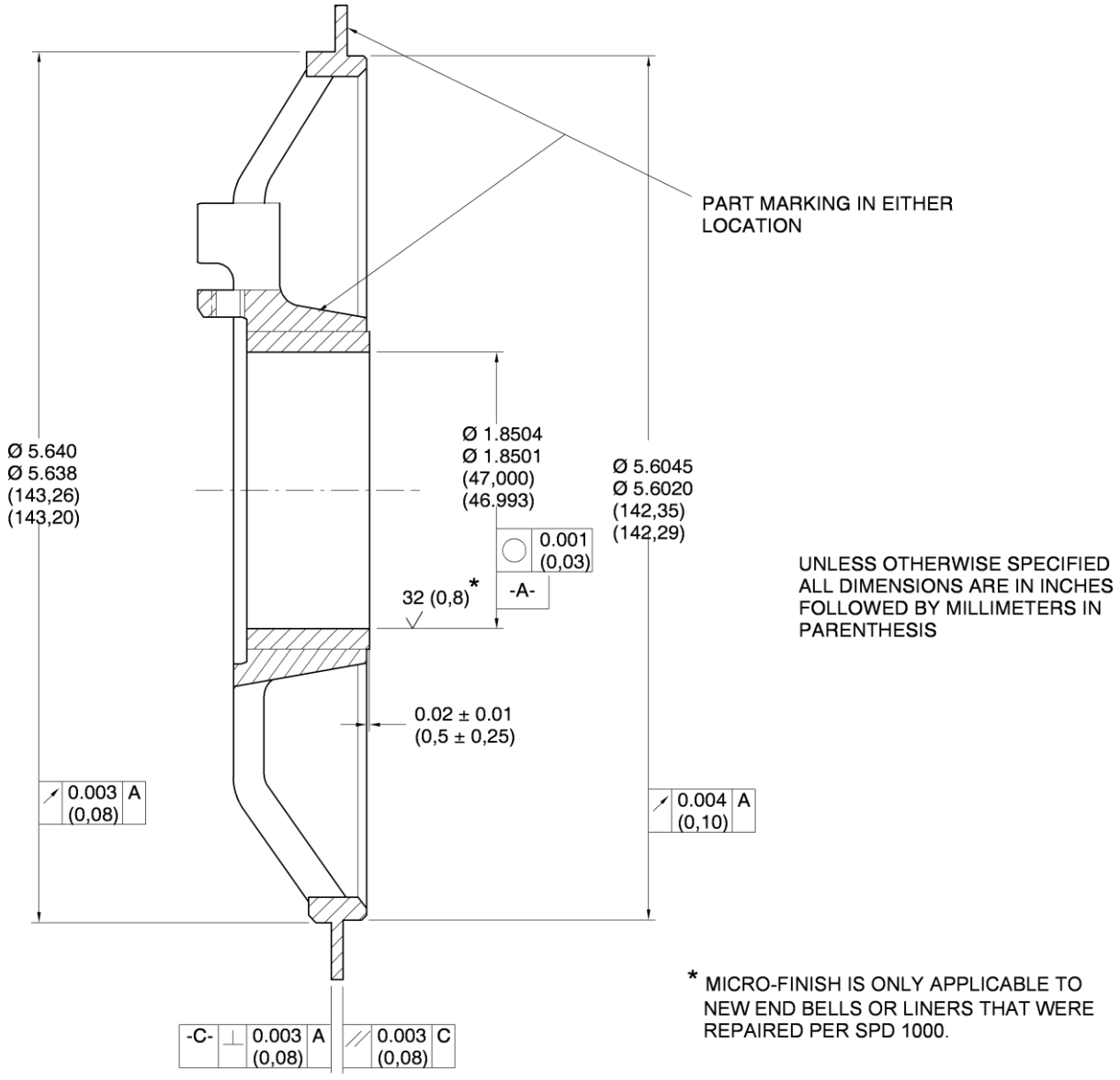



Figure 6004 - Drive End End Bell Bearing Liner Machining Specifications (Non-Preload)

## 8. Commutator Refinishing

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10001 of ILLUSTRATED PARTS LIST.

If inspection reveals that the commutator is rough, pitted, scored, or burned, refinish the commutator on a lathe that is accurately set up and adjusted.

NOTE: Refinish the commutator during each overhaul.

### A. Setup.

**WARNING: MAKE SURE THE POWER TO THE LATHE IS SHUT OFF OR "LOCKED OUT" WHILE PREPARING THE MACHINE FOR COMMUTATOR RE-FINISHING. USE ALL SAFETY PRECAUTIONS WHILE WORKING WITH OR AROUND POWER MACHINE TOOLS. WEAR EYE PROTECTION.**

(1) Install a bearing (530) into the commutator turning fixture.

(2) Position the drive end of the armature (500) shaft at the lathe chucking head and the commutator turning fixture in a tail stock.

(3) Insert the commutator end of the armature (500) into the commutator turning fixture.

### B. Repair Procedure. See Figure 6005.

**CAUTION:** DO NOT REMOVE TOO MUCH MATERIAL FROM THE COMMUTATOR. IF YOU DO, THE LIFE OF THE COMMUTATOR WILL BE DECREASED.

**CAUTION:** DO NOT TOUCH THE COMMUTATOR WITH YOUR BARE HANDS. CONTAMINATION FROM YOUR SKIN CAN CAUSE CORROSION AND UNSATISFACTORY ELECTRICAL CONTACT.

(1) Cut the commutator to a surface finish of 64 to 100 microinches (1,6 to 2,5 microns) RMS. The finish surface must extend from the end of the full undercut to the end of the commutator.

NOTE: The suggested feed rate is 0.006 to 0.007 inch (0,15 to 0,18 mm) per revolution at a surface speed of 1,000 to 1,500 surface feet per minute (305 to 457 surface meters per minute).

**WARNING:** **WHEN USING COMPRESSED AIR FOR CLEANING OR DRYING, CONTROL PRESSURE TO 29 PSIG (200 KPA) OR LESS. WEAR GOGGLES OR FACE SHIELD TO PROTECT EYES. TAKE PRECAUTIONS TO AVOID INJURY TO OTHER PERSONNEL IN AREA.**

**CAUTION:** MAKE SURE THAT COMPRESSED AIR USED TO CLEAN OR DRY COMPONENTS IS FREE FROM OIL AND WATER. THIS WILL PREVENT CONTAMINATION OF THE COMPONENTS.

(2) Clean the armature (500) surfaces with compressed air, 29 PSIG (200 kPa) maximum.

(3) Measure the depth of the mica undercut between the commutator bars. Refer to the FITS AND CLEARANCES section for limits.

(4) If the undercut is out of limits, use a 0.31 to 0.50 inch (7,9 to 12,7 mm) diameter cutter wheel to undercut the mica to a depth of 0.050 to 0.070 inch (1,27 to 1,78 mm) and a width of 0.035 to 0.045 inch (0,89 to 1,14 mm).

NOTE: The beginning of mica undercut must be from 0.01 to 0.03 inch (0,25 to 0,76 mm) max. from the finished face of the risers. All cuts must be equally spaced and parallel with the centerline of the armature shaft within 0.005 inch (0,13 mm) of true position. All mica must be removed from the edges of the undercut.

(5) Use a triangular scraping tool to remove sharp edges and burrs.

(6) Remove the undercut residue from between the commutator bars with a soft bristle brush.

**WARNING:** **WHEN USING COMPRESSED AIR FOR CLEANING OR DRYING, CONTROL PRESSURE TO 29 PSIG (200 KPA) OR LESS. WEAR GOGGLES OR FACE SHIELD TO PROTECT EYES. TAKE PRECAUTIONS TO AVOID INJURY TO OTHER PERSONNEL IN AREA.**

**CAUTION:** MAKE SURE THAT COMPRESSED AIR USED TO CLEAN OR DRY COMPONENTS IS FREE FROM OIL AND WATER. THIS WILL PREVENT CONTAMINATION OF THE COMPONENTS.

(7) Clean the armature (500) surfaces with compressed air, 29 PSIG (200 kPa) maximum.

(8) After the commutator is refinished

(a) Measure the commutator bar-to-bar and total indicator reading (TIR) run-out in full circumference of the commutator. Support the armature (500) on two “V” blocks.

(b) Make sure that the armature (500) is balanced IAW procedures found in Paragraph 9.

(9) If the armature (500) cannot be repaired to the limits in the FITS AND CLEARANCES section, replace the armature (500).

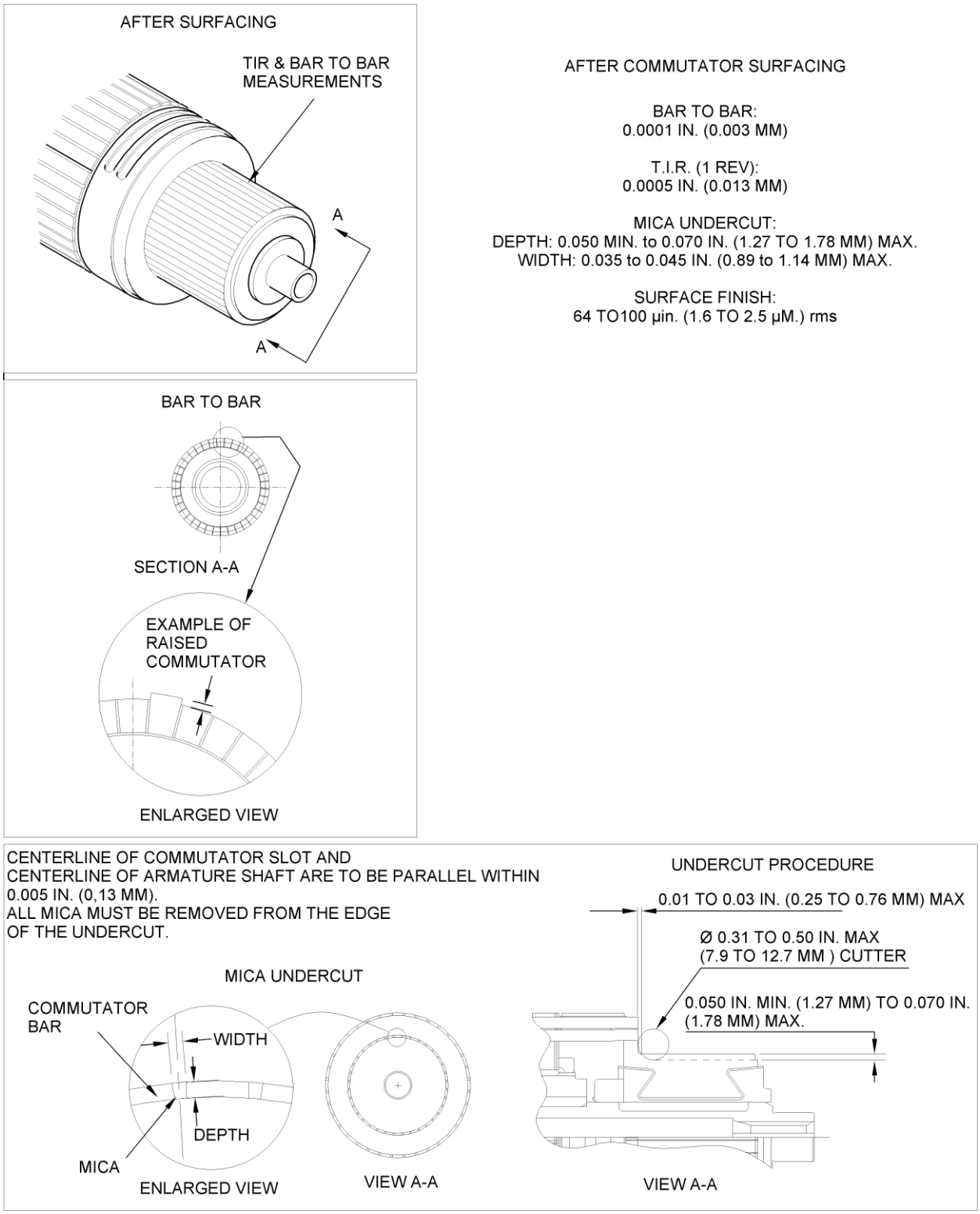



Figure 6005 - Armature Repair

## 9. Balancing the Armature

### A. Procedure.

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10001 of ILLUSTRATED PARTS LIST.

(1) Balance the armature (500) to the requirements listed in the FITS AND CLEARANCES section of this CMM according to the procedure in SPD 1001.

## 10. Restoring the Surface Coatings of Parts and Assemblies

### A. Removal of surface coatings.

Remove the surface coatings of parts and assemblies that have been damaged using plastic blasting equipment and procedures in accordance with (IAW) SPD 1003.

NOTE: Follow the quality assurance guidelines listed in SPD 1003 for the use of plastic media blasting equipment.

### B. Restoration of surface coatings.

Restore surface coating of parts and assemblies with materials and procedures given in Safran Power SPD 1002.

Clean all parts. Refer to CLEANING section of this CMM.

Use Table 6003 to find the correct primer and paint specification when using SPD 1002.

**WARNING: CHEMICAL CONVERSION MATERIALS ARE POISONOUS AND CAN CAUSE EXPLOSIONS WHEN MIXED WITH ACIDS, REDUCING AGENTS COMBUSTIBLE AND OXIDIZING MATERIALS. ISOLATED STORAGE OF THESE MATERIALS IS MANDATORY.**

**WARNING: BEFORE YOU USE CHEMICAL CONVERSION MATERIALS, PUT ON A RESPIRATOR, RUBBER APRON, RUBBER GLOVES AND EYE PROTECTION. THIS WILL PREVENT INJURY FROM SPILLS AND FROM THE FUMES.**

**WARNING: KEEP CHEMICAL CONVERSION MATERIALS AWAY FROM SOURCES OF HEAT, SPARKS AND FLAME. CHEMICAL CONVERSION MATERIALS ARE FLAMMABLE.**

| Item Number | Nomenclature | Process | Coating Repair |
|---|---|---|---|
| 10005-50 | Mounting Adapter | Refinish | Chemical Film touch-up IAW MIL-C-5541, Class 3 or Wash Primer and touch up paint |
| 10001-100 | Air Inlet | Refinish | Chemical Film touch-up or Wash Primer and touch up paint |
| 10001-160 | Brush Access Cover | Refinish | Chemical Film touch-up or Wash Primer and touch up paint |
| 10001-290 | Dampener Back Plate | Refinish phosphate | Re-phosphate IAW TT-C-490 or Phosphate touch-up |
| 10001-310 | Spur Gear | Refinish phosphate | Re-phosphate IAW TT-C-490 or Phosphate touch-up |
| 10001-540 | Stator and Housing Assembly. Housing can be refinished. | Refinish | Chemical Film touch-up or Wash Primer and touch up paint |
| 10002-10 | Anti-drive end end bell | Refinish | Chemical Film touch-up IAW MIL-C-5541, Class 3 |
| 10003-10 | Drive end end bell | Refinish | Chemical Film touch-up IAW MIL-C-5541, Class 3 |
| 10003-20 | Screen | Refinish Chem Film | Chemical Film touch-up IAW MIL-C-5541, Class 1A |

Table 6003 - Refinishing Procedures

## 11. Polarizing the Output Voltage

NOTE: If the polarity of the output voltage of a DC starter-generator has been reversed, this can be corrected by polarizing the field.

### A. Setup

**CAUTION:** NO OTHER POWER SUPPLY IS TO BE CONNECTED TO THE STARTER-GENERATOR.

(1) Connect a 6 VDC, wet cell battery (or 6 VDC power supply) and bump switch in series with the starter-generator field, as shown in Figure 6006.

(2) Connect the negative lead to terminal stud E.

(3) Connect the positive lead and bump switch to terminal stud A.

### B. Procedure

**CAUTION:** DO NOT POLARIZE THE FIELD WHILE THE STARTER-GENERATOR IS IN OPERATION.

(1) Turn the power ON and turn bump switch ON for a maximum of five seconds to polarize the field.

NOTE: If the polarity of the field has not been corrected, check for incorrect connections or a defective field circuit.

(2) Turn the power OFF and disconnect the leads.

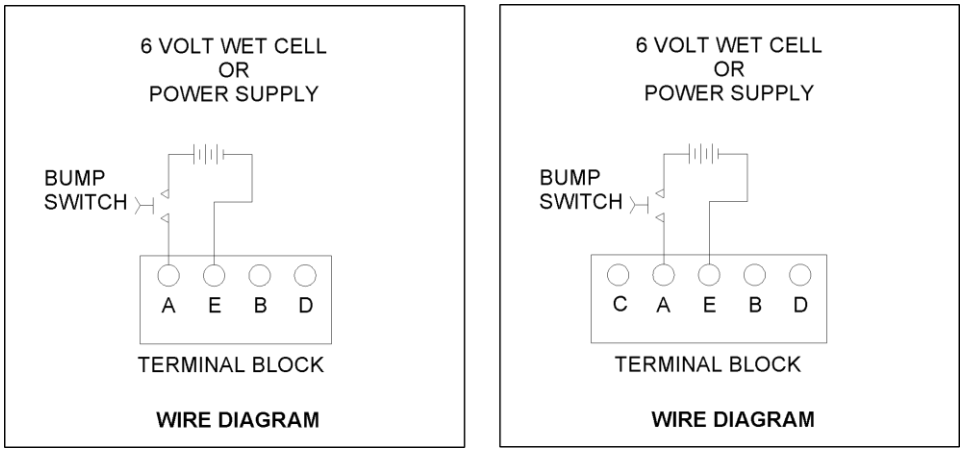



Figure 6006 - Terminal Block Schematic for Polarizing the Output Voltage

## 12. Brush Access Cover

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10001 of ILLUSTRATED PARTS LIST.

### A. Repair the brush access cover (160) as follows:

(1) Replace the insulating tape. See Figure 6007.

(a) Remove all signs of the insulating tape and clean the inside surface of the brush access cover (160). Refer to the CLEANING section.

(b) If the plating on the inner surface of the brush access cover (160) is damaged, coat the surface IAW the instructions in Paragraph 10.

(c) Cut the leading edge of the insulating tape square with the sides of the roll.

(d) Starting at one of the two sides of the brush access cover (160), line up the sides of the roll with the side of the brush access cover.

(e) Apply the insulating tape directly from the roll to the inner surfaces of the brush access cover (160).

NOTE: Installed insulating tape must be within 0.06 inch (1,5 mm) of the brush access cover (160), edges and ends. The insulating tape can overlap the brush access cover (160) edges by 0.02 inch (0,5 mm) on one side only. However, overlap is not permitted at the brush access cover (160) ends.

(f) Cut off unwanted insulating tape at the brush access cover (160) ends.

(2) Replace self-locking blind rivet nut (180) as follows. See Figure 6012.

(a) Remove self-locking blind rivet nut (180) from brush access cover (160) by drilling a 0.250 inch (6,35 mm) hole through self-locking blind rivet nut (180). The inboard and outboard sides of self-locking blind rivet nut (180) should become loose and fall off.

NOTE: A PlusNut® Fastener Header tool is required for repair procedure.

(b) Turn 1/2 inch (12,7 mm) nut in a counterclockwise direction until stud is fully extended. Engage all threads on stud in self-locking blind rivet nut (180) until nut is tight against tool face.

(c) Insert fastener header tool into hole in brush access cover (160).

(d) Use a 3/4 inch (19 mm) open ended wrench on tool body while holding tool stationary using a 3/4 inch (19 mm) socket wrench on 1/2 inch (12,7 mm) nut. While holding tool perpendicular to hole, turn tool clockwise.

NOTE: Do not overtighten self-locking blind rivet nut (180). Over-tightening can cause damage to threads.

(e) Turn nut until firm resistance is felt. Self-locking blind rivet nut (180) should be physically reformed. If self-locking blind rivet nut (180) is loose, tighten nut until self-locking blind rivet nut (180) is secure. Loosen nut by turning counterclockwise.

(f) Remove fastener header tool from self-locking blind rivet nut (180) by turning counterclockwise.

(g) Torque test self-locking blind rivet nut (180) to 60 lbf.in. (6,8 N·m).

(h) If the plating on the outer surface of the blind rivet nut (180) is damaged, coat the surface IAW the instructions in Paragraph 10.

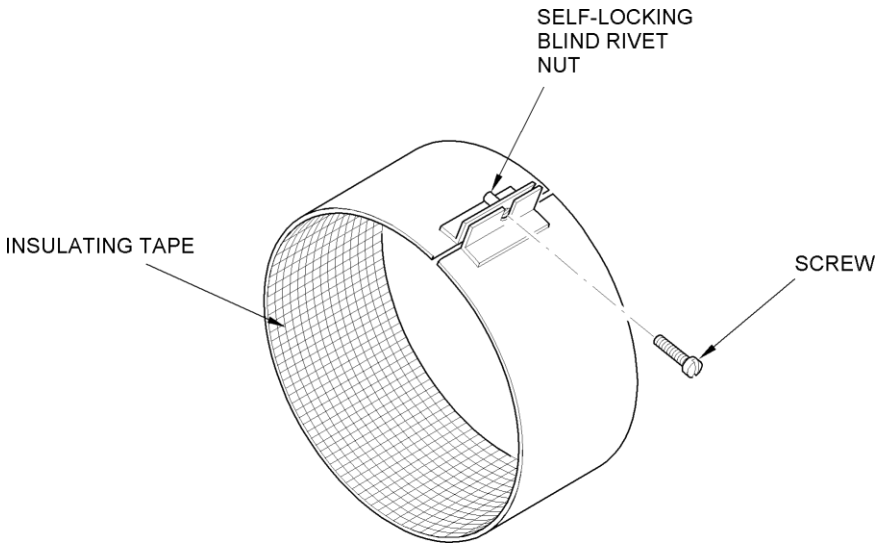



Figure 6007 - Brush Access Cover

## 13. Repair of the Complete Brush Holder

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10002 of ILLUSTRATED PARTS LIST.

### A. Repair the complete brush holder (30) as follows:

(1) Disassembly of complete brush holder (30).

(a) Using a #40 drill bit, remove 2 rivets (120) from brush lead terminal board (100).

(b) Remove and discard brush lead terminal board (100) and insulating sheet (110).

(c) Repeat Paragraph 13.A.(1)(a) and Paragraph 13.A.(1)(b) for each brush holder (30).

(2) Assembly of complete brush holder (30). See Figure 6008.

(a) Secure rivet alignment fixture to press table.

(b) Secure rivet press tool to arbor press.

(c) Place insulating sheet (110) and brush lead terminal board (100) onto the brush holder (40) and insert two rivets (120) through the holes.

NOTE: When parts are correctly aligned, the section of insulating sheet (110) which extends outside the brush lead terminal board (100) will fold up against the brush holder (40).

(d) Set the brush holder (40) upside down onto rivet alignment fixture and align the rivets (120) with the two cones on the fixture.

(e) Press rivets (120) as shown in Figure 6008. The diameter of the rivet head must be a minimum of 1.5 times the diameter of the rivet.

(f) Repeat Paragraph 13.A.(2)(a) through Paragraph 13.A.(2)(e) for the remaining complete brush holder (30) assemblies.

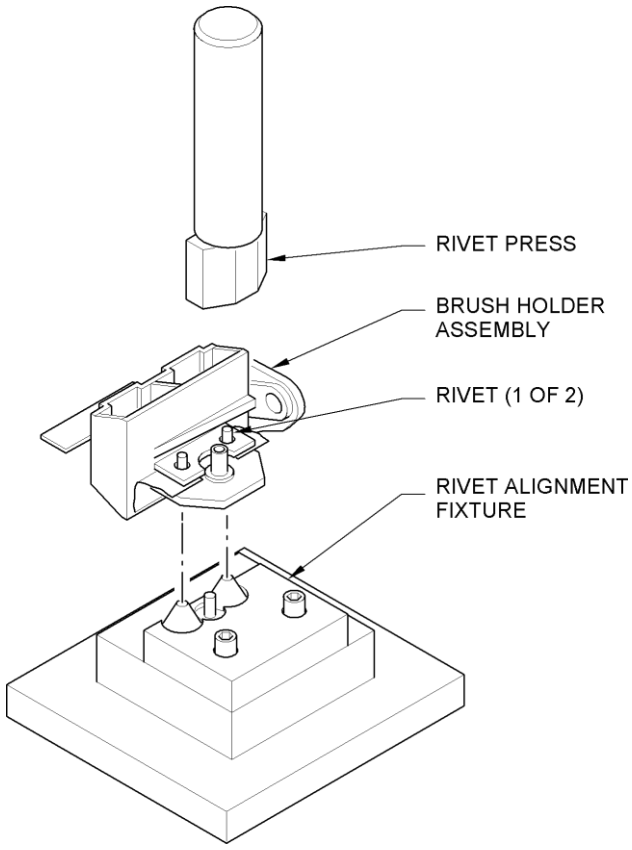



Figure 6008 - Brush Holder Rivet Alignment

## 14. Replacement of B or E Terminal Block Studs, All Models except 23080-056

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10004 of ILLUSTRATED PARTS LIST.

### A. Removal.

Two methods are available to remove studs (50) from terminal block (80):

- Using a stud removal tool.
- Using two nuts.

(1) Remove terminal studs from the terminal block with the stud removal tool as follows:

(a) Screw the stud removal tool onto one of the terminal studs.

(b) Apply force in counter-clockwise direction to drive head of the stud removal tool.

(c) Rotate the stud removal tool until the terminal stud is removed from the terminal block.

(d) Remove the terminal stud from the stud removal tool:

1 Move the clutch ring away from the collet holder.

2 Hold the collet holder with a wrench and turn the drive head of the stud removal tool in clockwise direction until the tension is released between the stud removal tool and the terminal stud.

3 Screw the terminal stud out of the hex collet.

(e) Do these steps again to remove the other terminal stud.

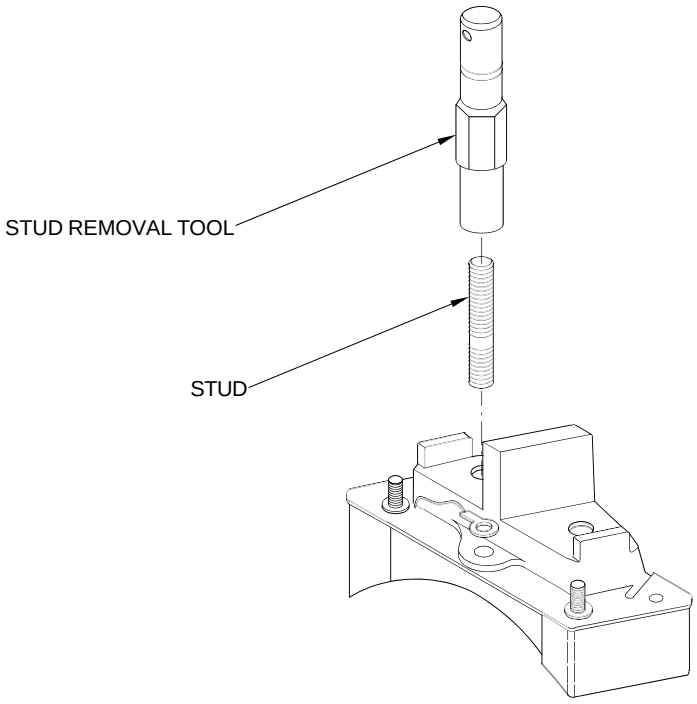



Figure 6009 - Removal of Terminal Studs with Stud Removal Tool

(2) Stud removal using two nuts.

(a) Put one nut (10) upside down on the stud (50).

(b) Put another nut (10), correct way up, on the same stud (50). See Figure 6010. Use two open ended wrenches to tighten the two nuts (10) together.

(c) Turn the bottom nut (10) in a counter-clockwise direction with an open ended wrench, to remove the stud (50).

(d) Remove the two nuts (10) from the stud (50).

(e) Repeat this process on the other terminal stud.

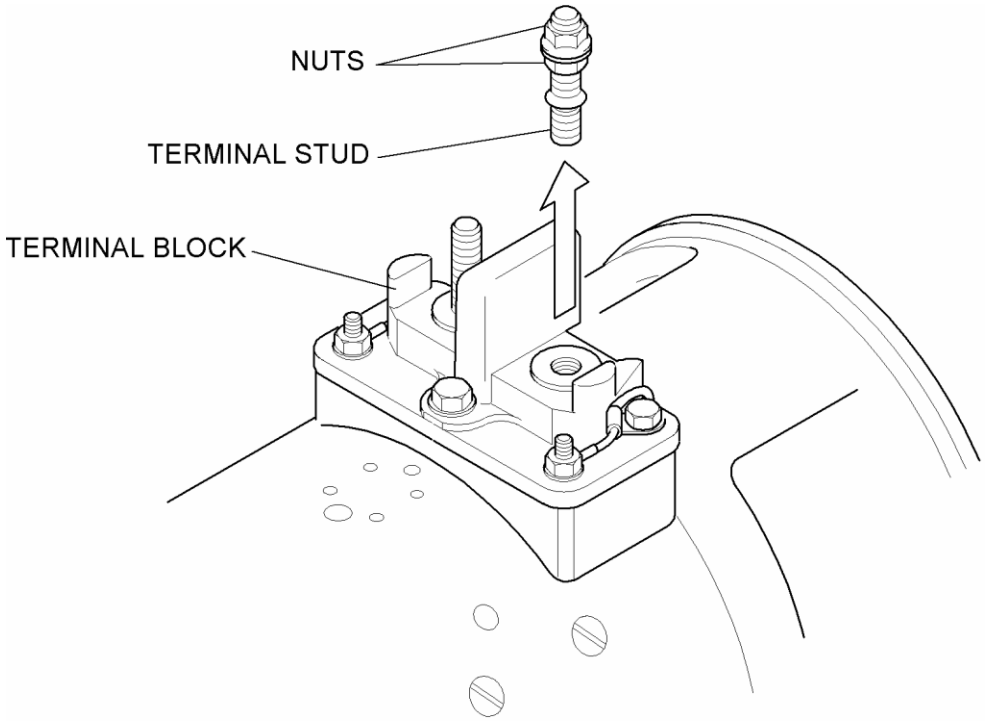



Figure 6010 - Terminal Block Stud Removal Using Two Nuts

**B. Cleaning**

(1) Clean the threads in the terminal block with a wire brush.

**WARNING: ISOPROPYL ALCOHOL CAN BE DANGEROUS TO PERSONS. USE ONLY IN AN AREA WITH A GOOD FLOW OF AIR. KEEP AWAY FROM SOURCES OF IGNITION. DO NOT BREATHE THE FUMES. PREVENT SKIN CONTACT. PUT ON PROTECTIVE CLOTHING AND EYE PROTECTION.**

(2) Use a cotton swab with Isopropyl alcohol to remove any residue.

**C. Install Terminal Studs B and E (50) into Terminal Block (80). See Figure 6011.**

(1) Installation of terminal stud with stud driver tool:

(a) Screw the stud driver onto one of the two terminal studs.

NOTE: To make adjustments to the stud engagement length, lift the clutch ring and turn the drive head.

NOTE: The stud driver tool can be powered by hand or can be attached to a non-impacting power tool.

**WARNING: THE THREADLOCK PRIMER IS FLAMMABLE. DO NOT OPERATE NEAR OPEN FLAMES, WELDING AREAS OR ON HOT SURFACES.**

(b) Spray threadlock primer (7649) on the threads of the threaded insert in the terminal block where the stud will be installed.

(c) Spray threadlock primer (7649) on the threads of the stud that will engage with the terminal block threaded insert threads.

(d) Let the threadlock primer (7649) dry for 70 seconds.

**WARNING: THE THREADLOCKER IS FLAMMABLE. DO NOT OPERATE NEAR OPEN FLAMES, WELDING AREAS OR ON HOT SURFACES.**

(e) Apply threadlocker (243) on the threads of the stud that will engage with the terminal block threaded insert threads. Apply a full 360° around the threads.

(f) Immediately install the terminal stud through the hole in one of the large stator leads (and washer if applicable) and into the terminal block by turning stud driver tool.

(g) Tighten the stud to 300 to 325 in-lbs. (33.9 to 36.7 Nm) torque.

NOTE: Make sure the flange on the terminal stud is fully seated against the terminal block.

(h) Remove the stud driver by turning it counter-clockwise until it releases from the terminal stud.

(i) Do these steps again to install the other terminal stud.

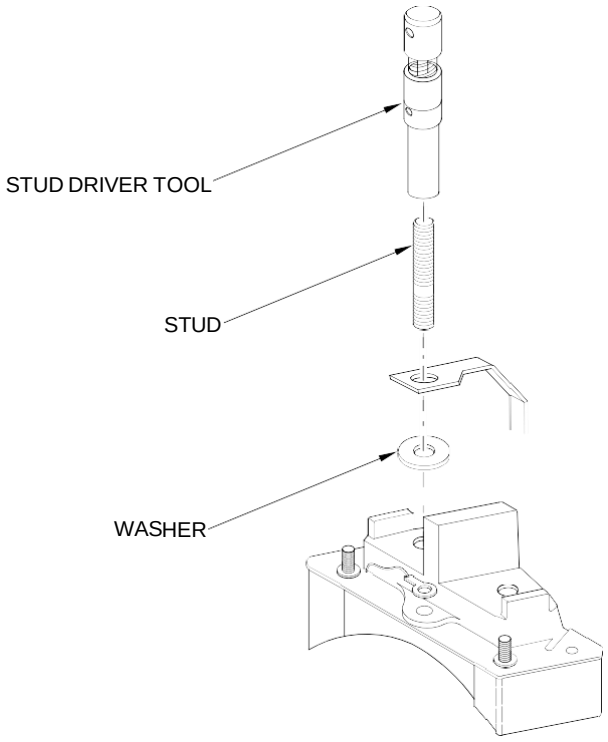



Figure 6011 - Installation of Terminal Stud with Stud Driver Tool

## 15. Terminal Lug Replacement

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10004 of ILLUSTRATED PARTS LIST.

**A. Remove and replace damaged terminal lugs (130) as needed.**

(1) Cut wire at base of terminal(s). Discard terminal(s).

(2) Strip 0.25 inch (6,4 mm) insulation from end of electrical wire(s).

(3) Use a crimping tool to install new terminal(s).

## 16. Insulator Grommet Replacement. All Models except 23080-056.

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10004 of ILLUSTRATED PARTS LIST.

**A. Replace the insulator grommet (160) as follows:**

(1) Remove the insulator grommet (160) with pliers or a knife.

(2) Slide a new insulator grommet (160) over the stator lead.

NOTE: Make sure the curvature of the grommet is the same curvature as the housing.

(3) Press the insulator grommet (160) in place.

## 17. Removal and replacement of the Mounting Adapter Guide Pin

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10005 of ILLUSTRATED PARTS LIST.

Use the following repair procedure to remove and replace the mounting adapter guide pin (60).

**A. Tools**

A set of pliers, vice grips or suitable tool that lets you grip the guide pin (60) and pull it out.

**B. Procedure (See Figure 6012)**

(1) Secure the mounting adapter (50) in a vice making sure it is secured enough to handle the force required to pull the guide pin (60).

(2) Using the suitable tool, twist and pull on the guide pin (60) until it releases from the mounting adapter (50).

**WARNING: PRIMER CAN BE DANGEROUS TO PERSONS. USE ONLY IN AN AREA WITH A GOOD FLOW OF AIR. KEEP AWAY FROM SOURCES OF IGNITION. DO NOT BREATHE THE FUMES. PREVENT SKIN CONTACT. PUT ON PROTECTIVE CLOTHING AND EYE PROTECTION. IF NECESSARY, PUT ON A RESPIRATOR.**

(3) Apply zinc chromate primer to the new guide pin (60) before inserting into the mounting adapter (50).

(4) Insert a new guide pin (60) into the hole in the mounting adapter (50).

(5) Using an arbor press or light hammer, lightly tap the guide pin (60) into the hole.

NOTE: The finished height of the guide pin (60) is as follows:

| | |
|---|---|
| Model 23080-056 | 0.18 to 0.20 inch (4,57 to 5,08 mm) |
| Models 23080-002, -004, -023, -023A, -023B, -058 | 0.14 to 0.16 inch (3,56 to 4,06 mm) |
| Models 23291-005, | 0.14 to 0.16 inch (3,56 to 4,06 mm) |

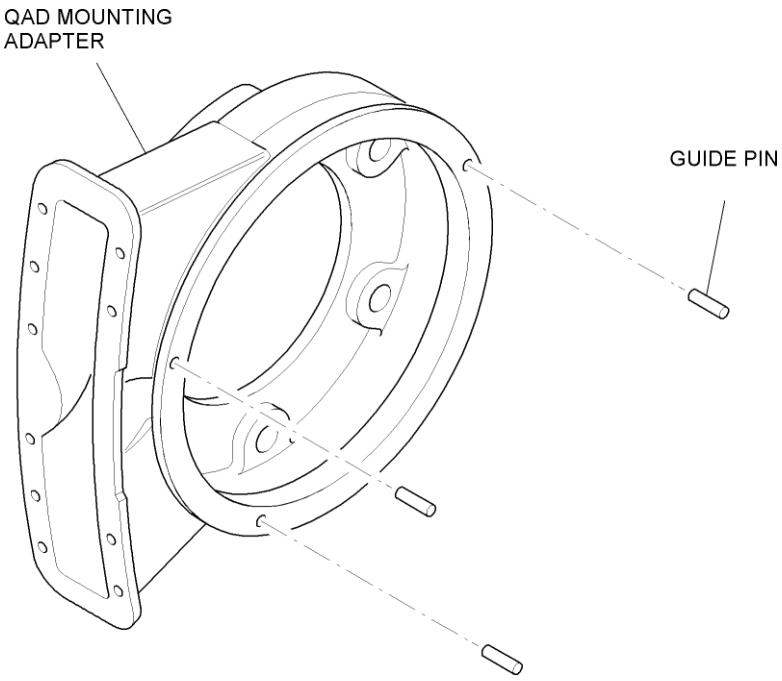



Figure 6012 - Repair of the Mounting Adapter Guide Pin

## 18. QAD Kit Air Adapter Seal Replacement

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10005 of ILLUSTRATED PARTS LIST.

### A. Procedure.

(1) Remove 12 drive screws (80) and 12 washers (90).

NOTE: Not applicable to P/N 23080-500.

(2) Using a scraper, remove damaged seal (70) and all remaining seal material from mounting adapter (50) seal mounting surface.

**WARNING: ISOPROPYL ALCOHOL IS TOXIC AND FLAMMABLE. DO NOT USE NEAR OPEN FLAMES, WELDING AREAS, OR ON HOT SURFACES. INHALATION OF VAPORS CAN CAUSE DROWSINESS, DIZZINESS, AND HEADACHE. CONTACT WITH SKIN CAN CAUSE IRRITATION. USE IN A WELL-VENTILATED AREA.**

(3) Use isopropyl alcohol and a cleaning pad to clean mounting adapter (50) seal mounting surface. Allow surface to dry.

**WARNING: DO NOT GET SILICONE ADHESIVE ON YOUR SKIN OR IN YOUR EYES. YOU MUST PUT ON PVC GLOVES AND EYE PROTECTION. IF YOU GET SOME ON YOUR SKIN, FLUSH WITH WATER. IF YOU GET SOME IN YOUR EYES, FLUSH WITH CLEAN WATER AND GET MEDICAL AID.**

(4) Apply silicone adhesive line of approximately 0.4 inch (10 mm) wide, to seal mounting surface on mounting adapter (50).

(5) Assemble new seal (70) on mounting adapter (50). Center seal all around on air outlet. Figure 6013.

NOTE: Limited pressure is required to assemble parts.

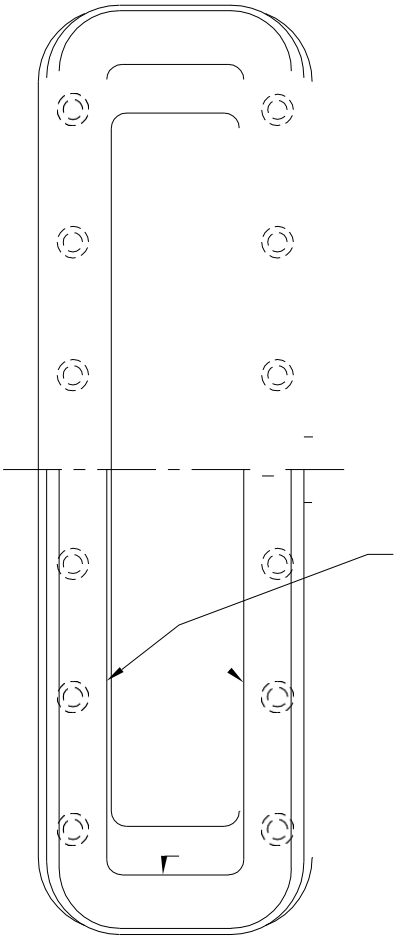
(a) Make sure the mounting adapter seal does not reduce the length or the width of the inside of the cast duct by more than the value in Figure 6013.

(6) Remove too much adhesive using a cleaning pad and isopropyl alcohol.

(7) Attach seal to mounting adapter with 12 drive screws (80) and 12 flat washers (90).

NOTE: Not applicable to P/N 23080-500.

(8) Allow silicone adhesive to cure at room temperature for 24 hours.



TYPICAL VIEW

THE MOUNTING ADAPTER SEAL MUST BE CENTERED AROUND THE COMPLETE PERIMETER OF THE MOUNTING ADAPTER OPENING. THE MOUNTING ADAPTER SEAL MUST NOT REDUCE THE LENGTH OR THE WIDTH OF THE INSIDE OF THE CAST DUCT OPENING BY MORE THAN THE VALUE IN THE TABLE BELOW:

| ADAPTER AND SEAL ASSEMBLY P/N: | MAX VALUE FOR THE ADAPTER SEAL OVERLAP: |
|---|---|
| 23080-1030 | NOT APPLICABLE |
| 23080-1035 | 0.080 IN. (2,03 MM) MAX |
| 23080-1037 | 0.080 IN. (2,03 MM) MAX |
| 23080-1038 | 0.080 IN. (2,03 MM) MAX |
| 23080-2060 | 0.050 IN. (1,27 MM) MAX |
| 23080-2061 | 0.050 IN. (1,27 MM) MAX |
| 23080-2062 | 0.050 IN. (1,27 MM) MAX |

Figure 6013 - Repair of the Seal on the Mounting Adapter and Seal Assembly

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# ASSEMBLY

## 1. Introduction

This Section gives assembly instructions for DC Starter-Generators 23291 Series. Assemble the unit in a clean work area away from machining or other metal removing operations. Clean all parts in accordance with (IAW) instructions in the CLEANING section before final assembly.

In addition to specific procedures authorized by Safran Power in this manual, standard assembly procedures for starter-generators are described in the following Safran Power Standard Practice Documents (SPDs).

- Surface Repair and Coating - Refer to SPD 1002.
- Brush Holder Alignment Fixtures - Refer to SPD 1004.
- Brush Installation, Seating, and Run-In - Refer to SPD 1006.

## 2. Assembly Tools

In addition to normal shop tools, specific tools for assembly of the starter-generator are listed in Table 7001.

NOTE: Equivalent substitutes can be used for the tools listed in Table 7001.

| Tool Description | Reference |
|---|---|
| Arbor Press | Commercially Available |
| Brush Holder Alignment Fixture | SPD 1004 |
| Dampener Plate Driver | Figure 9007 |
| Heat Gun | Commercially Available |
| Horizontal Stator Support | Figure 9016 |
| Inner Race Bearing Driver | Figure 9004 |
| Leather or Plastic Mallet | Commercially Available |
| Outer Race Bearing Driver | Figure 9005 |
| DELETED | |
| Pliers, Snap Ring | Commercially Available |
| Plug, Speed Pickup Adjustment (for use on starter-generators without bearing pre-load feature) | Figure 9010 |
| Plug, Speed Pickup Adjustment (for use on starter-generators with bearing pre-load feature) | Figure 9011 |
| Spline Wrench | Figure 9019 |
| Support, Armature | Figure 9012 |

Table 7001 - Assembly Tools

| Tool Description | Reference |
|---|---|
| Support, Anti-Drive End Hub | Figure 9014 |
| Supports, Drive End Bearing Hub | Figure 9015 |
| Support, Vertical Shaft | Figure 9018 |
| Support, Vertical Stator | Figure 9017 |
| Terminal Block - Unserviceable (Optional) | None |
| Torque wrench | Commercially Available |
| Wire Hook Tool | Commercially Available |

Table 7001 - Assembly Tools (Continued)

## 3. Assembly materials

Materials necessary for starter-generator assembly are listed in Table 7002.

NOTE: Assembly materials are not available from Safran Power. All items can be purchased commercially.

**WARNING: BEFORE USING ONE OF THE FOLLOWING MATERIALS, BE AWARE OF ALL HANDLING, STORAGE, AND DISPOSAL PRECAUTIONS RECOMMENDED BY THE MANUFACTURER OR SUPPLIER. FAILURE TO COMPLY WITH THE RECOMMENDATIONS CAN RESULT IN SERIOUS INJURY, PHYSICAL DISORDER, OR DEATH.**

| Item | Description/Specification | Source (CAGE Code) |
|---|---|---|
| Acrylic Coating | HumiSeal Type 1B31, Type AR MIL-I-46058 | Chase Corporation<br>Woodside, NY 11377<br>Ph: (718) 932-0800<br>Fax: (718) 932-4345<br>www.humiseal.com<br>(V0SR97) |
| Cloth | Lint-free | Commercially Available |
| Enamel, Red Insulating | Synthite ER-41 | John C. Dolph Company<br>320 New Road, PO Box 267<br>Monmouth, NJ 08852<br>Ph: (732) 329-2333<br>Fax: (732) 329-1143<br>www.dolphs.com<br>(V72688) |

Table 7002 - Assembly Materials

| Item | Description/Specification | Source (CAGE Code) |
|---|---|---|
| Epoxy bonding cement | Two part resin: Safran Power P/N 02-7001-27 filled | Ellsworth Adhesives P.O. Box 1002 W129 N10825 Washington Dr. Germantown, WI 53022-8202 Ph: 1-800-888-0698 FAX: 1-262-253-8619 www.ellsworth.com (V0PYJ1) |
| Isopropyl Alcohol<br><br>See **WARNING** before using this material. | TT-I-735, Grade A<br><br>Flash Point: 53° F (12° C), FLAMMABLE. Refer to the Material Safety Data (MSD) Sheet for the material for additional safety information | Commercially Available |
| Lockwire | MS20995C20 and MS20995C32 | Commercially Available |
| Lubricating and Assembly Paste | Altemp QNB 50 | Klueber Lubrication Londonderry, NH Ph: (603) 647-4104 www.klueber.com (V3EZL6) |
| Masking Tape | N/A | Commercially Available |
| Protective Paper | MIL-B-121A, Grade A, Type II, Class I | National Paper and Packaging Co. Cleveland, OH 44103 www.nationalpaper.com (V0LAX1) |
| Sandpaper | 180 Grit, non-aluminum oxide | Commercially Available |
| Silicone Adhesive | RTV 732 White | Dow Corning Corporation P O Box 994 Midland, MI 48686-0994 Ph: (989) 496 7881 Fax: (989) 496 6731 www.dowcorning.com (V71984) |
| Sleeving, 1/8 inch (3,2 mm) | Heat Shrink/MIL-I-23053/5 | Commercially Available |
| DELETED | | |
| Solder | Resin Core, ANSI J STD-006, Type Sn 95 | Commercially Available |

Table 7002 - Assembly Materials (Continued)

| Item | Description/Specification | Source (CAGE Code) |
|---|---|---|
| Thread Locking Adhesive, Grade A | Loctite Grade A MIL-S-22473 | Loctite Corporation Aurora, IL Ph: (860) 571-5100 www.loctite.co m (V7V827) |
| Thread Locking Adhesive | Loctite Grade D MIL-S-22473 or Alternate: Loctite 263 | |
| Thread Sealing Compound | Lead Free/Soft Set Gasoila | GSA Supply on-line www.gsasupplyco.com or Federal Process Co. 4620 Richmond Rd. Beachwood, OH 44128 |
| Anti-Seize Compound, Never-Seez (Used only on brush band clamp) | Never-Seez, Regular Grade or, Meets MIL-A-907E | Never-Seez Compound Corp. or Denco Industrial Products, Vermilion, Ohio |

Table 7002 - Assembly Materials (Continued)

## 4. Assembly of Stator and Housing Assembly

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10004 of ILLUSTRATED PARTS LIST.

### A. Attach terminal block (80) to the stator and housing assembly.

NOTE: Applicable on if the terminal block was removed during acceptance testing.

(1) Set the unit onto a horizontal stator support.

(2) For all models except 23080-056, put a flat washer (150) on terminal studs B and E.

**CAUTION:** DO NOT BEND THE LARGE STATOR LEADS MORE THAN NECESSARY TO INSTALL THE TERMINAL BLOCK.

**CAUTION:** MAKE SURE SMALL TERMINAL LEADS A AND D ARE NOT UNDERNEATH TERMINAL BLOCK AS IT IS PUSHED INTO POSITION.

(3) Set terminal block (80) onto the stator and housing assembly and slide it into position in the large stator leads, B and E.

(4) Put the small stator lead terminal lugs (130) on studs A and D.

NOTE: For all models except 23080-056, place leads to terminal studs A and D in grooves in the terminal block (80).

(5) For all models except 23080-056:

(a) Put a tab-lock washer (100) and insulation (110) onto each of the two bolts (90).

(b) Put a tab-lock washer (70) on bolt (60).

(c) Put the two bolts (90) into the corner holes of the terminal block (80) and tighten the bolts (90) to a torque of 25.0 to 30.0 lbf.in (2,8 to 3,4 N·m).

(d) Put bolt (60) into the centre hole on the terminal block (80) and tighten the bolt (60) to a torque of 31.5 to 42.0 lbf.in (3,6 to 4,7 N·m).

(6) For model 23080-056:

(a) Put a lock washer (100) and flat washer (120) onto each of the two screws (90).

(b) Put the two screws (90) into the holes of the terminal block (80) and tighten two screws (90) to a torque of 7.7 to 10.3 lbf.in (0,87 to 1,16 N·m).

**B. Install hardware on terminal block (80). See** Figure 7001**.**

(1) Secure stator lead terminals A and D with flat washer (40) and self-locking nut (30) at each location.

NOTE: Do not tighten the nuts (30) on terminal block (80) studs A and D. They will be tightened at the time of installation into the aircraft. It is necessary to install the wires from the GCU at that time.

(2) Install one flat washer (20) and one self-locking nut (10) on each terminal stud, B and E.

NOTE: Do not tighten the nuts (10) on terminal block studs, B and E. They will be tightened at the time of installation into the aircraft.

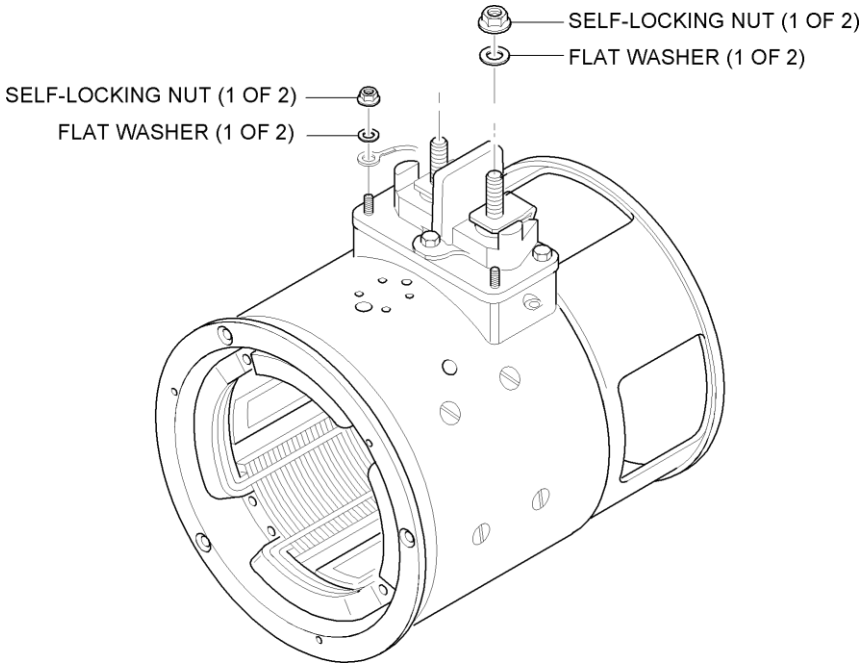


Figure 7001 - Installing Terminal Block Hardware

## 5. Assembly of Drive End Bearing Support Assembly

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10003 of ILLUSTRATED PARTS LIST.

**A. Attach the screen (20) to the drive end end bell (10).**

**WARNING: USE PROTECTIVE GLOVES AND GOGGLES WHEN USING LIQUID EPOXY RESINS.**

(1) Using a spatula, mix parts A and B of epoxy bonding cement equally on a smooth, flat surface until fully mixed.

(2) Apply a thin layer of mixture on each rib of drive end end bell (10).

(3) Put a flat washer (40) on each screw (30).

(4) Attach screen (20) to drive end end bell (10) in six places with screws (30) and flat washers (40).

(5) Place drive end bearing support assembly in oven and allow epoxy bonding cement to cure for 40 minutes at 200° F (97° C).

**WARNING:** **WEAR INSULATED GLOVES AND OBSERVE ALL SAFETY PRECAUTIONS WHEN HANDLING HEATED PARTS TO AVOID PERSONAL INJURY.**

(6) Remove drive end bearing support assembly from oven.

(7) Allow drive end bearing support assembly to cool to room temperature.

## 6. Assembly of the Bearing and Brush Support Assembly

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10002 of ILLUSTRATED PARTS LIST.

**A. Install the brush springs (130) on the complete brush holder (30). See Figure 7002.**

**CAUTION:** DO NOT WIND THE BRUSH SPRINGS TOO TIGHTLY OR THIS CAN RESULT IN REDUCED BRUSH SPRING RELIABILITY.

Wind the brush springs (130) about 3/4 turn and put two brush springs onto each brush holder (30) as shown in Figure 7002.

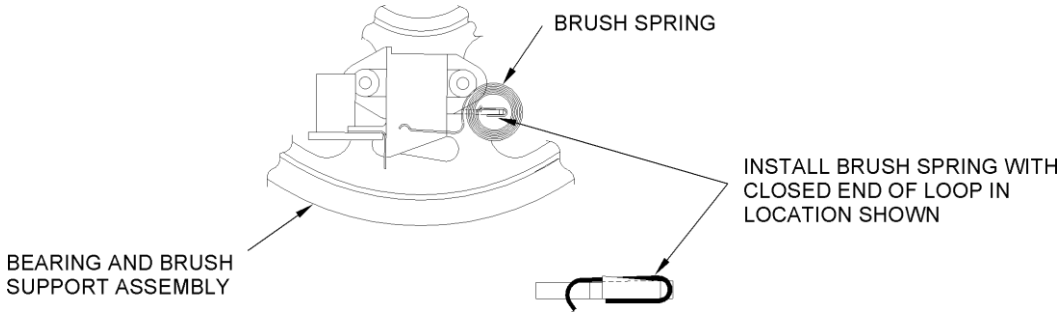


Figure 7002 - Brush Spring Installation

**B. Attach each complete brush holder (30) to the anti-drive end end bell (10). See Figure 7003 and Figure 7004.**

**CAUTION:** CORRECT INSTALLATION OF THE INSULATION SLEEVES IS CRITICAL. USE GREAT CARE WHEN INSERTING THE INSULATION SLEEVES INTO THE ANTI-DRIVE END END BELL. IF AN INSULATION SLEEVE IS PINCHED BETWEEN THE ANTI-DRIVE END END BELL AND A COMPLETE BRUSH HOLDER, CARBON DUST WILL COLLECT IN THE AREA WHERE THE INSULATION SLEEVE IS DAMAGED, CAUSING A PATH TO GROUND AND EQUIPMENT FAILURE. THE DAMAGE IS NOT DETECTABLE DURING THE DIELECTRIC TEST AFTER ASSEMBLY.

(1) Insert two insulation sleeves (80) at a brush holder location into two adjacent through holes in the anti-drive end end bell (10). Make sure the insulation sleeves (80) extend out of the through holes on both sides of the anti-drive end end bell (10).

(2) Put an insulating board (90) onto the ends of the exposed insulation sleeves (80) on the inboard side of the anti-drive end end bell (10).

(3) Put a non-metallic washer (60) onto the ends of each exposed insulation sleeves (80) on the outboard side of the anti-drive end end bell (10). Make sure the insulation sleeves (80) do not slide and that the insulating board (90) does not fall off.

(4) Put one flat washer (70) on each of two bolts (50).

(5) Insert one bolt (50) into each of two insulation sleeves (80) on the outboard side of the anti-drive end end bell (10). Make sure that the insulation sleeves (80) do not slide and that the insulating board (90) does not fall off.

**WARNING: THREAD LOCKING ADHESIVE IS FLAMMABLE. DO NOT USE NEAR OPEN FLAMES, NEAR WELDING AREAS, OR ON HOT SURFACES.**

(6) Apply thread locking adhesive, Grade D or loctite 263, to the threads of the two bolts (50).

(7) Put a complete brush holder (30) against the two bolts (50) on the inboard side of the anti-drive end end bell (10).

(8) Attach the complete brush holder (30) to the anti-drive end end bell (10) with the two bolts (50).

NOTE: ATTACH LOOSELY. DO NOT TIGHTEN THE BOLTS (50) AT THIS TIME.

(9) Repeat Paragraph 6.B.(1) through Paragraph 6.B.(8) for remaining brush holder locations.

(10) Lower the bearing and brush support assembly (10001-320) onto the brush holder alignment fixture as shown in Figure 7004.

**CAUTION:** MAKE SURE THE COMPLETE BRUSH HOLDERS ARE PROPERLY ALIGNED IN THE BRUSH HOLDER ALIGNMENT FIXTURE. IMPROPER ALIGNMENT CAN CAUSE ELECTRICAL FAILURE.

(11) Adjust all complete brush holders (30) until they are properly aligned. Refer to SPD 1004.

(12) Tighten bolts (50) to a torque of 25.0 to 30.0 lbf.in. (2,8 to 3,4 N·m).

(13) Remove the bearing and brush support assembly (10001-320) from the brush holder alignment fixture.

**WARNING:** **INSULATING ENAMEL IS TOXIC AND FLAMMABLE. DO NOT BREATHE VAPORS. USE IN A WELL VENTILATED AREA FREE FROM SPARKS, FLAME AND/OR HOT SURFACES. WEAR SPLASH GOGGLES, SOLVENT-RESISTANT GLOVES, AND OTHER PROTECTIVE GEAR. IN CASE OF EYE CONTACT, FLUSH WITH WATER AND SEEK MEDICAL ATTENTION. IN CASE OF SKIN CONTACT, WASH WITH SOAP AND WATER.**

(14) Apply insulating enamel to bearing and brush support assembly according to the procedure in SPD 1002.

**C. Perform a dielectric test.**

(1) Perform a dielectric test of the bearing and brush support assembly. Refer to the CHECK section.

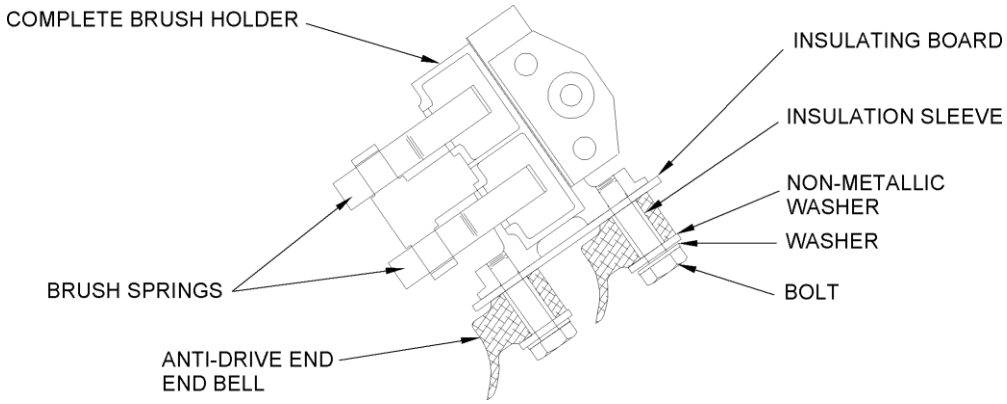


Figure 7003 - Bearing and Brush Support Assembly Detail

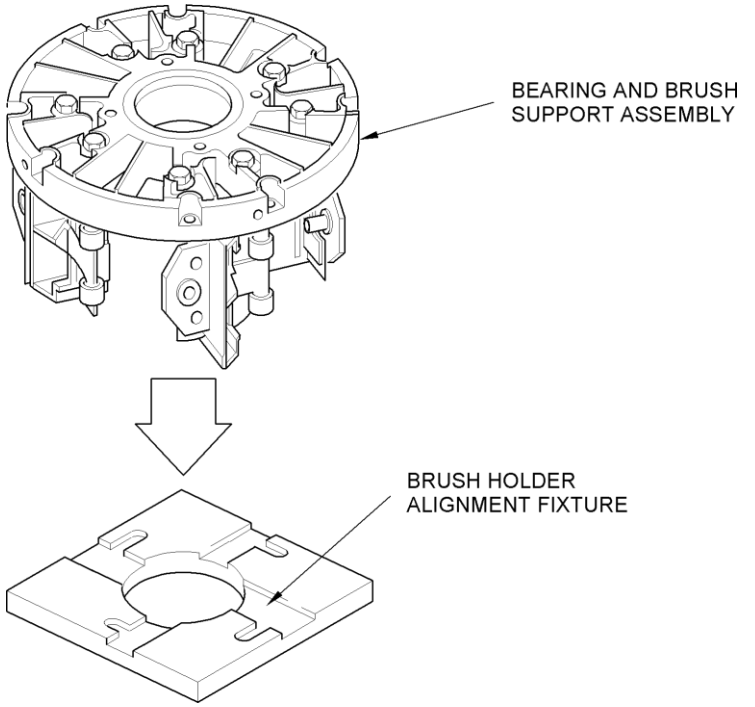


Figure 7004 - Aligning the Brush Holders

**D. Press anti-drive end ball bearing (530) into bearing and brush support assembly (320). See Figure 7005.**

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers given in Figure 10001 of the ILLUSTRATED PARTS LIST.

**CAUTION:** FAILURE TO USE ANTI-DRIVE END HUB SUPPORT DURING ASSEMBLY OPERATIONS CAN CAUSE PERMANENT DAMAGE TO BEARING AND BRUSH SUPPORT ASSEMBLY.

(1) Set anti-drive end hub support on arbor press table.

(2) Set bearing and brush support assembly (320), brush holders down, on anti-drive end hub support.

**WARNING: DO NOT LET PASTE TOUCH THE EYES OR SKIN. OBEY THE MANUFACTURER'S INSTRUCTIONS. REFER TO MSDS SHEET BEFORE PASTE IS USED.**

(3) Apply lubricating and assembly paste to the inside diameter of the bearing liner and assemble the bearing with the part marking facing the outside of the unit.

(4) Set anti-drive end bearing on bearing liner of bearing and brush support assembly.

NOTE: The Safran Power part marking on the anti-drive end ball bearing (530) must be facing towards the outside of the starter-generator.

(5) Set outer race bearing driver onto anti-drive end ball bearing.

(6) Press anti-drive end ball bearing into bearing and brush support assembly bearing liner.

(7) Make sure that anti-drive end ball bearing is fully installed against inner lip of bearing liner.

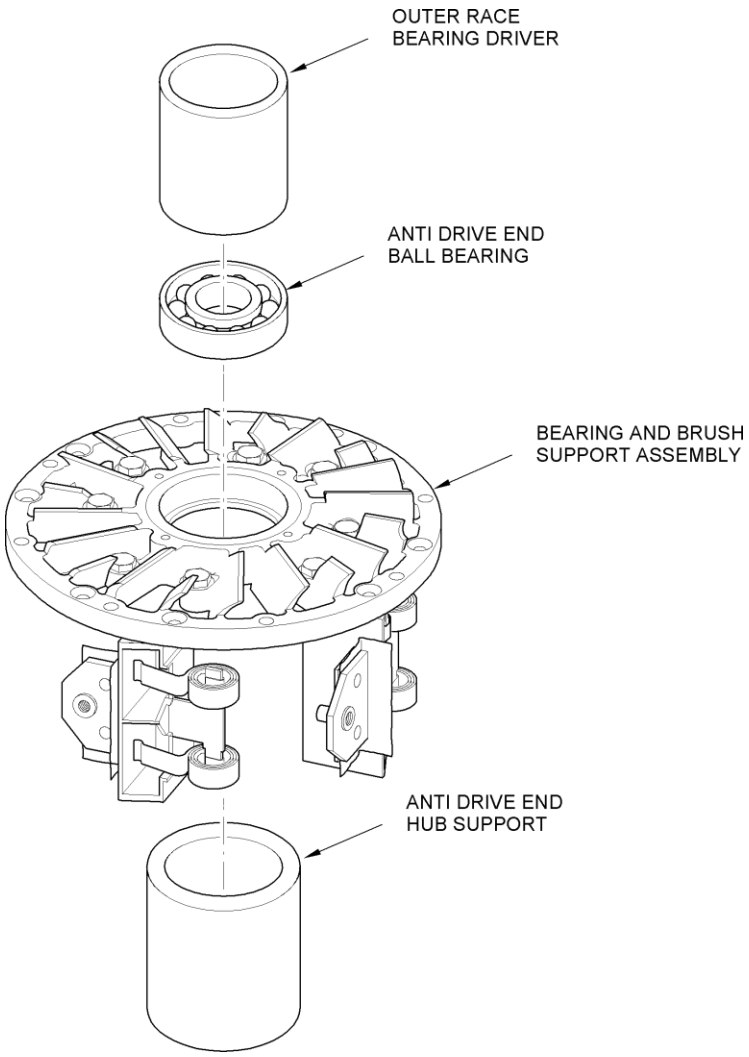


Figure 7005 - Anti-Drive End Bearing Installation

**E. Attach bearing retainer (510) to bearing and brush support assembly (320). See Figure 7006.**

**WARNING: THREAD SEALING COMPOUND IS DANGEROUS TO PERSONS. USE ONLY IN AN AREA WITH A GOOD FLOW OF AIR. KEEP AWAY FROM SOURCES OF HEAT, SPARKS AND FLAME. DO NOT BREATHE THE FUMES. PREVENT SKIN CONTACT. PUT ON PROTECTIVE CLOTHING AND EYE PROTECTION.**

(1) Apply thread sealing compound to threads of four screws (520).

(2) Attach bearing retainer (510) to bearing and brush support assembly (320) with four screws (520). Torque screws from 13.5 to 18.0 lbf.in (1,5 to 2,0 N·m).

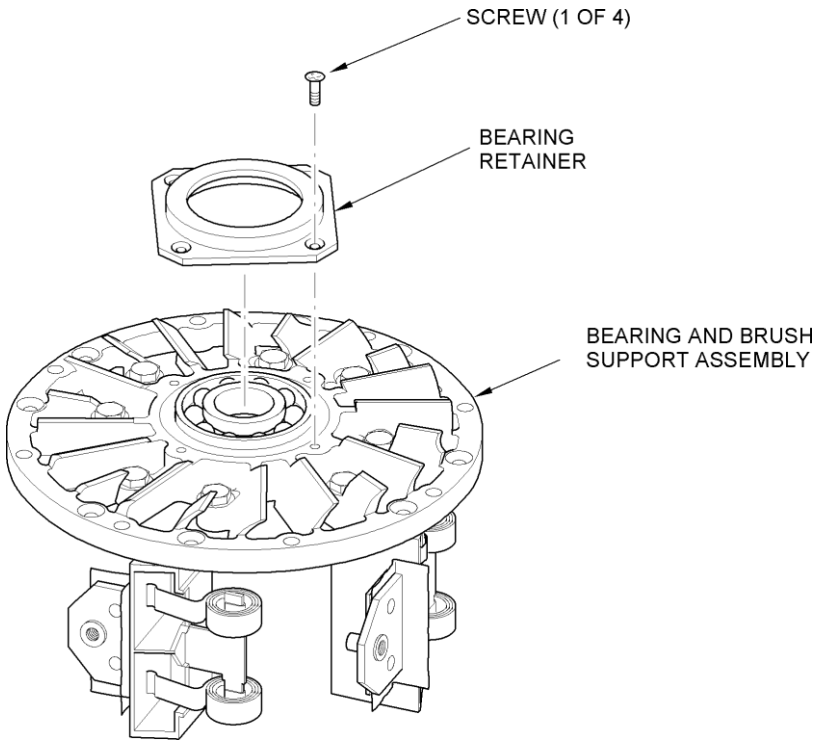


Figure 7006 - Installing Bearing Retainer

**F. Prepare armature (500) for coarse brush seating. See** Figure 7007.

(1) Prepare the armature for coarse brush seating. Refer to SPD 1006.

NOTE: Make sure taped end of sandpaper is in the normal direction of rotation and abrasive side of sandpaper faces away from the commutator.

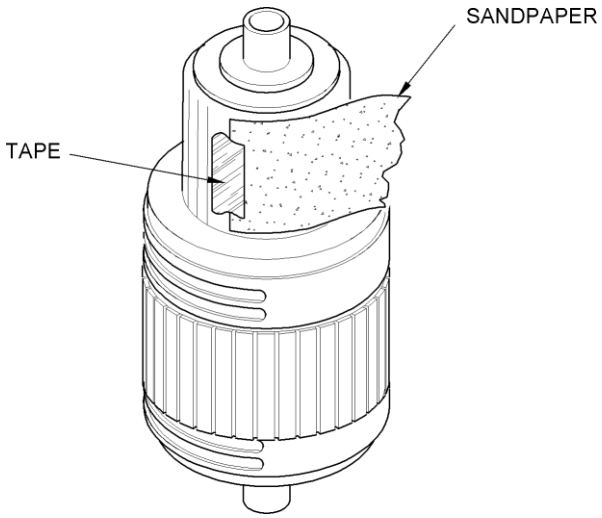


Figure 7007 - Preparing Armature for Rough Seating

**G. Press bearing and brush support assembly (320) onto armature (500) shaft. See** Figure 7008**.**

**CAUTION:** DO NOT TOUCH POLISHED SURFACE OF COMMUTATOR WITH BARE HANDS. SKIN ACIDS AND OILS CAN CONTAMINATE CONDUCTING SURFACES CAUSING CORROSION AND/OR POOR ELECTRICAL CONTACT.

(1) Place the armature (500) on an armature support on an arbor press table with the commutator pointing upward.

(2) Set bearing and brush support assembly (320), brush holders down, on commutator end of armature shaft.

(3) Set inner race bearing driver on anti-drive end ball bearing (530).

(4) Press anti-drive end ball bearing onto armature shaft.

(5) Make sure that anti-drive end ball bearing is fully installed against shoulder of armature shaft.

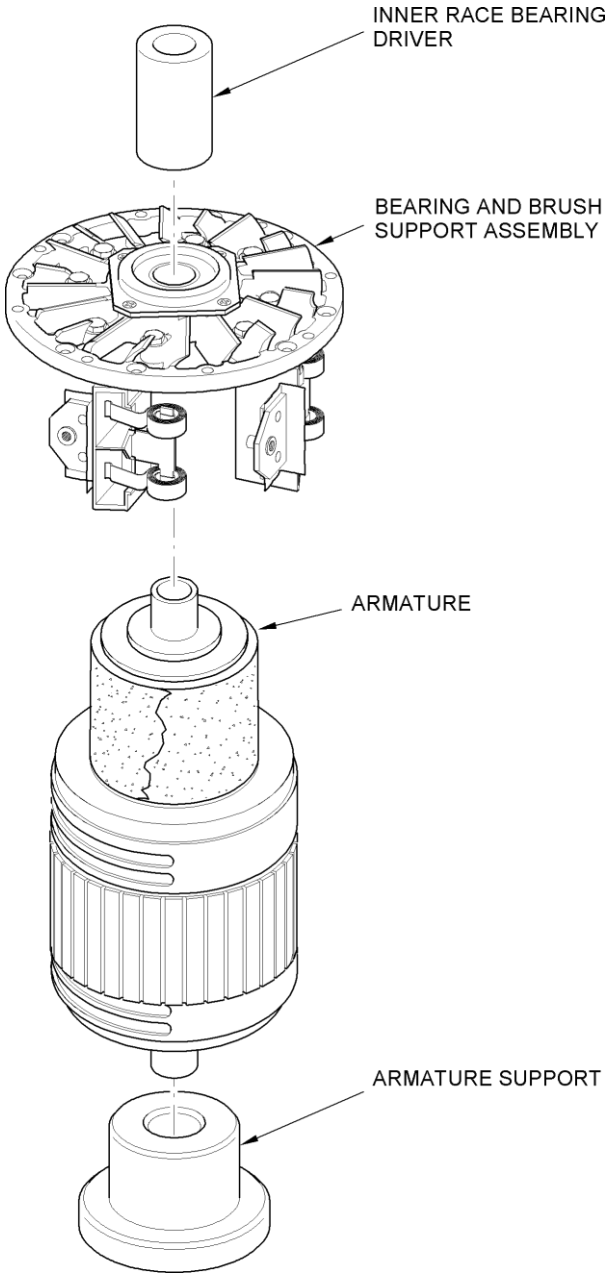


Figure 7008 - Armature on Armature Support

## 7. Attach Speed Pickup (420) and Grommet (440) to the Drive End Bearing Support Assembly (400).

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers given in Figure 10001 of ILLUSTRATED PARTS LIST.

**A. Procedure. See Figure 7009.**

(1) Press the grommet (440) into an opening in the screen (10003-20) of the drive end bearing support assembly (400).

(2) Insert applicable speed pickup adjustment plug into the bearing liner of the drive end bearing support assembly.

(3) Screw the speed pickup (420) through the threaded hole in the drive end bearing support assembly.

(4) Adjust the speed pickup until the tip of the speed pickup lightly touches the speed pickup adjustment plug. Tighten the speed pickup jam nut to a torque of 15.0 to 25.0 lbf.in. (1,7 to 2,8 N·m).

NOTE: The gap will be adjusted after the spur gear is assembled.

(5) Remove speed pickup adjustment plug.

NOTE: Paragraph 7.A.(6) and Paragraph 7.A.(7) apply to speed pickup 23072-1280 only. Speed pickup 23072-1400 does not require sleeving.

(6) If the heat shrink sleeving was removed during disassembly, put a piece of 1/8 inch (3,2 mm) diameter heat shrinkable sleeving over the speed pickup leads.

(7) Shrink the sleeving into place on the leads with a heat gun.

(8) Thread speed pickup leads through grommet (440).

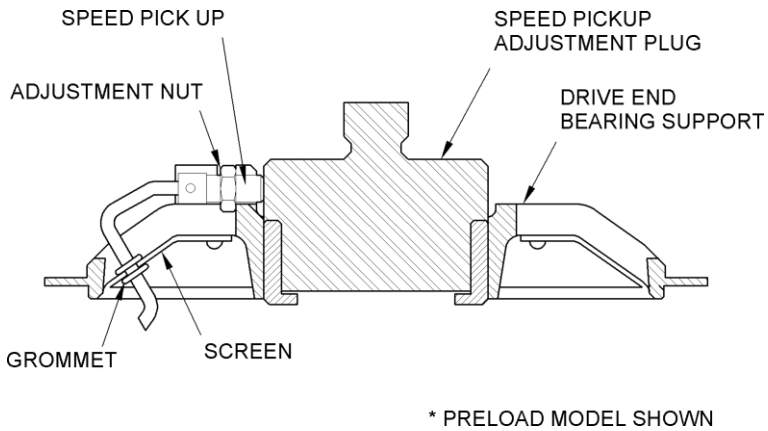


Figure 7009 - Adjusting the Speed Pickup

**8. For (Non-Preload) Models Only, Follow These Instructions for Installing Drive End Bearing Support and Bearing and Brush Support Assembly.**

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers given in Figure 10001 of ILLUSTRATED PARTS LIST.

**A. Assemble the drive end bearing support assembly (400) to the stator and housing assembly (540). See Figure 7010.**

(1) Place the stator and housing assembly (540) vertically on the work bench with the drive end up.

(2) While holding drive end bearing support assembly (400), thread the speed pickup (420) leads through the stator and housing assembly (540) and out the hole.

NOTE: Sometimes it is easier to slide a separate 12 inch (305 mm) length of wire through the hole and pass between the stator poles out to the drive end. Attach this extra wire to the speed pickup (420) leads. Pull out the extra wire as the speed pickup (420) leads are pulled in on the same path. Disconnect the extra wire.

(3) Place the drive end bearing support assembly (400) on the stator and housing assembly (540). Align the speed pickup (420) unit towards the terminal block (10004-80) on the stator and housing assembly (540).

**WARNING: THREAD SEALING COMPOUND IS DANGEROUS TO PERSONS. USE ONLY IN AN AREA WITH A GOOD FLOW OF AIR. KEEP AWAY FROM SOURCES OF HEAT, SPARKS AND FLAME. DO NOT BREATHE THE FUMES. PREVENT SKIN CONTACT. PUT ON PROTECTIVE CLOTHING AND EYE PROTECTION.**

(4) Apply thread sealing compound to threads of three screws (410).

(5) Attach the drive end bearing support assembly (400) to the stator and housing assembly (540) with the screws (410).

(6) Tighten the three screws (410) to a torque of 7.7 to 10.3 lbf.in. (0,87 to 1,16 N·m).

NOTE: Make sure that the head of the screws (410) are flush or below face of the drive end bearing support assembly (400) when installed.

NOTE: The speed pickup (420) leads can dangle outside the stator and housing assembly (540) until connected in later paragraphs.

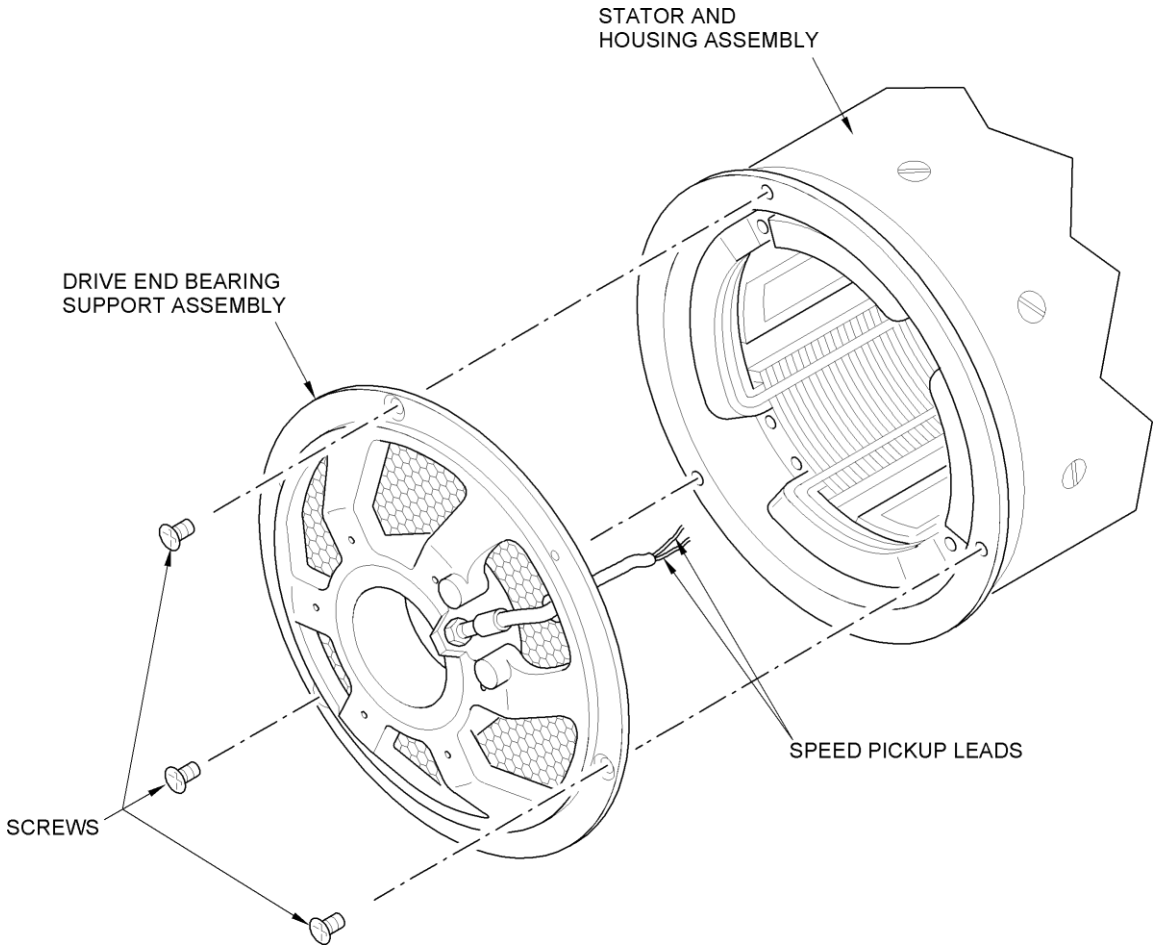


Figure 7010 - Installing Drive End Bearing Support Assembly (Non-Preload)

**B. Press the drive end ball bearing (450) onto the armature (500) shaft.**

(1) Place the armature (500) on the work bench with the bearing and brush support assembly (320) down.

NOTE: The armature assembly will sit on its bearing retainer plate on the bottom.

(2) Slide a baffle disc (350), concave side to armature, or spacer (350) onto the armature shaft.

NOTE: The Safran Power part marking on the bearing (450) must be facing towards the outside of the starter-generator.

(3) Lightly press a ball bearing (450) on the armature (500) shaft. Use an inner race bearing driver to finish pressing the bearing in an arbor press.

(4) Make sure the ball bearing is fully installed against the baffle disc/spacer.

**C. Assemble the bearing and brush support assembly (320) (with attached armature (500) to the stator and housing assembly (540). See Figure 7011 and Figure 7012.**

(1) Place the stator and housing assembly (540) drive end down, into the outboard hub support on the work bench. Tuck the four brush harness straps to the side.

(2) Insert the armature (500) with the attached bearing and brush support assembly (320) into the stator and housing assembly.

(3) Make sure the four brush harness straps are within reach of the brush holders. Align the holes of the bearing and brush support assembly (320) with the threaded holes in the stator and housing assembly (540).

(4) If the bearing and brush support assembly (320) is not installed against the housing, it will have to be pressed on. Use an inner race bearing driver on the anti-drive end bearing (530) and gently tap with a mallet or use an arbor press to install the assembly.

(5) Put a flat washer (340) onto each of eight self-locking screws (330).

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(6) Apply thread sealing compound to threads of screws (330).

(7) Attach the bearing and brush support assembly to the stator and housing assembly with eight screws (330) and washers (340). Tighten the screws (330) to a torque of 13.5 to 18.0 lbf.in. (1,53 to 2,03 N·m).

(8) For all models except 23080-056, slide speed pickup gear (310) onto the drive end of the armature (500) shaft. The inner rim on the speed pickup gear (310) faces the drive end bearing (450). See Figure 7013.

(9) For model 23080-056, slide shaft spacer (430) onto the drive end of the armature (500) shaft.

(10) Install a new retaining ring (300) into the groove of the armature (500) shaft. Make sure retaining ring is fully installed.

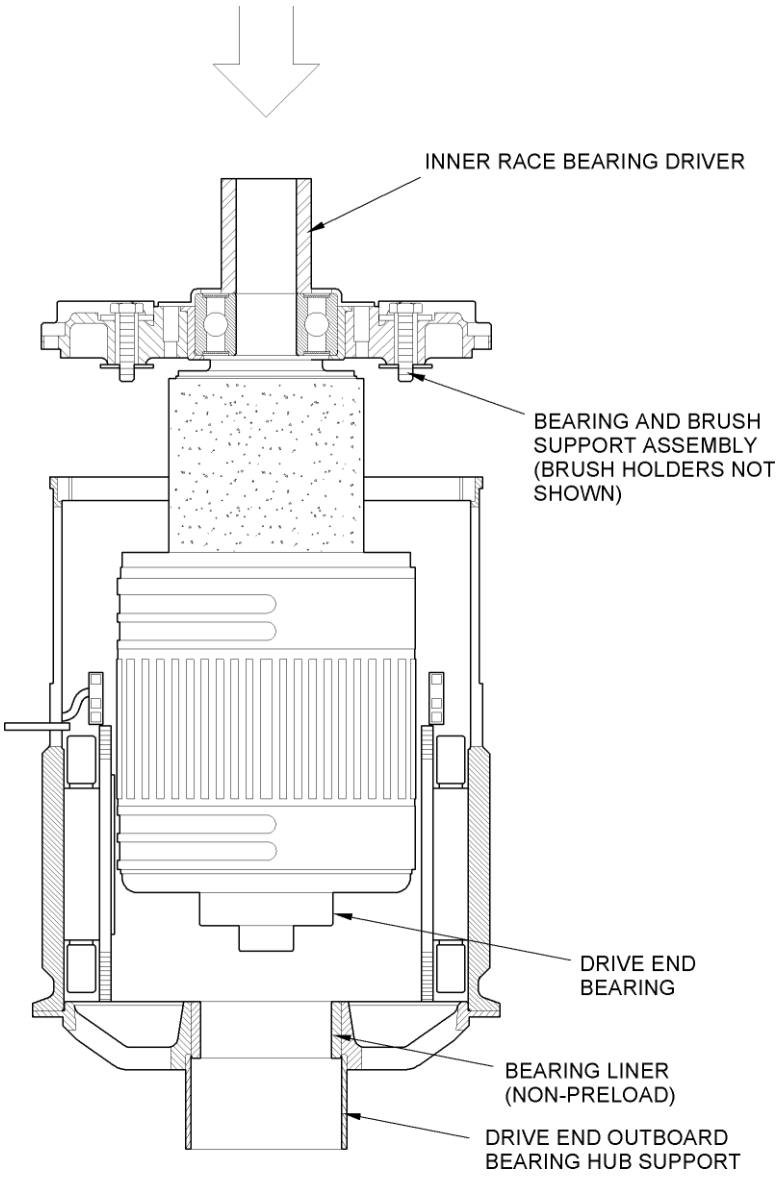


Figure 7011 - Pressing the Bearing and Brush Support Assembly with Attached Armature into the Stator and Housing Assembly (Non-Preload)

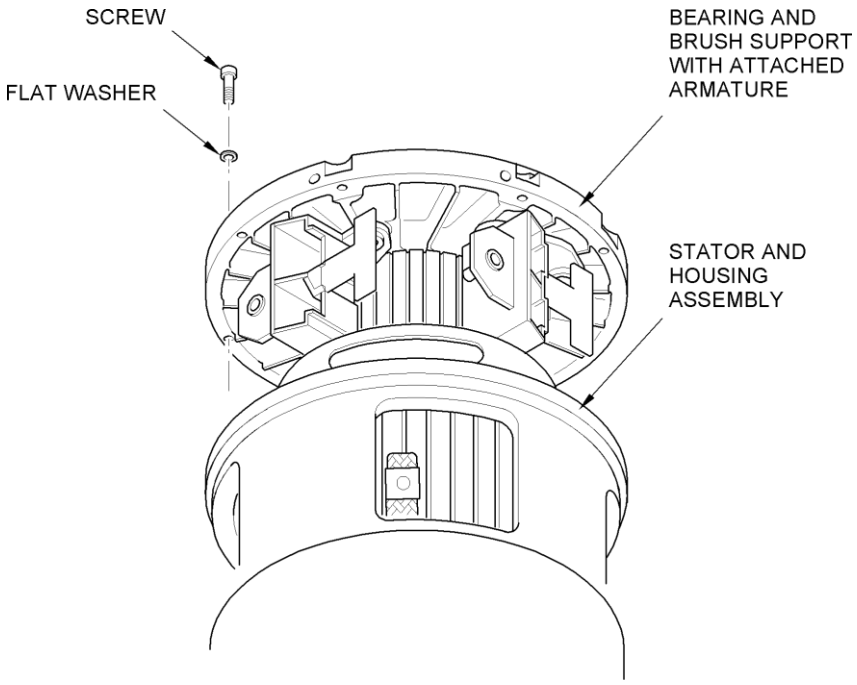


Figure 7012 - Installing the Bearing and Brush Support Assembly with Attached Armature to Stator and Housing Assembly (Non-Preload)

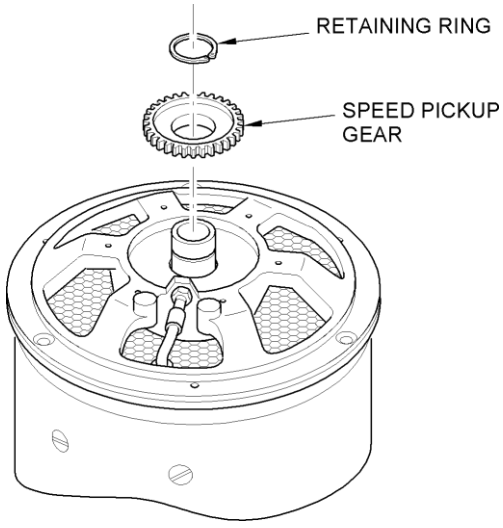


Figure 7013 - Installing Speed Pickup Gear and Retaining Ring onto Armature Shaft (Non-Preload)

**9. For (Pre-load) Models, Follow These Instructions for Installing Both Drive End Bearing Support and Bearing and Brush Support Assembly.**

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers given in Figure 10001 of the ILLUSTRATED PARTS LIST.

**A. Assemble the drive end bearing support assembly (400) to the stator and housing assembly (540). See Figure 7014.**

(1) Place the stator and housing assembly (540) vertically on the work bench with the drive end up.

**CAUTION:** THE 23080-056 STARTER-GENERATOR MUST USE THE DRIVE END END BELL P/N 23080-3144 WITH FIVE (5) HOLES FOR MATING TO THE MOUNTING ADAPTER. OLD VERSIONS OF THE DRIVE END END BELL P/N 23080-3144 WITH THREE (3) HOLES WILL NOT WORK ON THE MOUNTING ADAPTER P/N 23080-1211 WHICH HAS DIFFERENT ALIGNMENT PINS THAN THE OLD MOUNTING ADAPTER P/N 23080-1210.

(2) While holding drive end bearing support assembly (400), thread the speed pickup (420) leads through the stator and housing assembly (540) and out the hole.

NOTE: Sometimes it is easier to slide a separate 12 inch (305 mm) length of wire through the hole and pass between the stator poles out to the drive end. Attach this extra wire to the speed pickup (420) leads. Pull out the extra wire as the speed pickup (420) leads are pulled in on the same path. Disconnect the extra wire.

(3) Place the drive end bearing support assembly (400) on the stator and housing assembly (540). Align the speed pickup (420) unit towards the terminal block (10004-80) on the stator and housing assembly (540).

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(4) Apply thread sealing compound to threads of three screws (410).

(5) Attach the drive end bearing support assembly (400) to the stator and housing assembly (540) with the screws (410).

(6) Tighten the three screws (410) to a torque of 7.7 to 10.3 lbf.in. (0,87 to 1,16 N·m).

NOTE: Make sure that the head of the screws (410) are flush or below face of the drive end bearing support assembly (400) when installed.

NOTE: The speed pickup (420) leads can dangle outside the stator and housing assembly (540) until connected in later paragraphs.

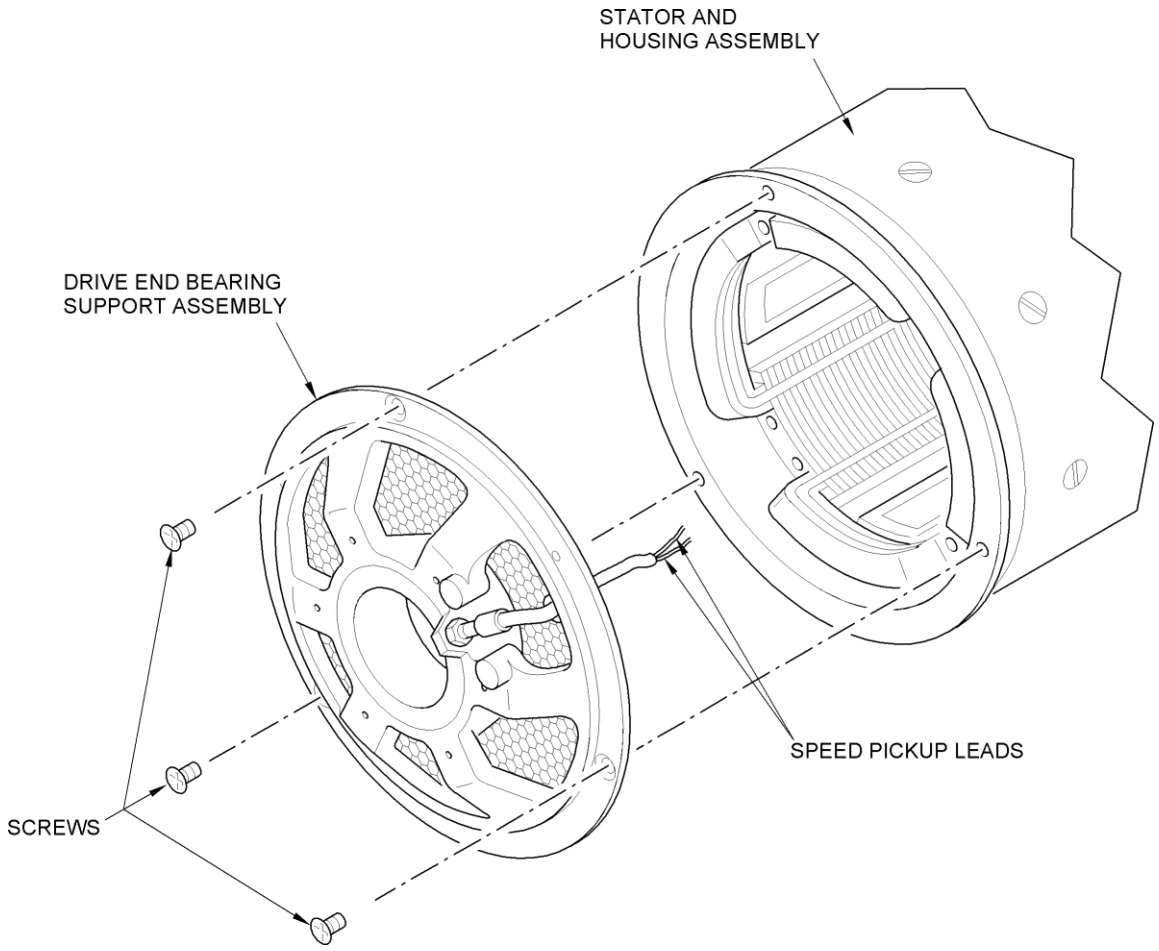


Figure 7014 - Installing Drive End Bearing Support Assembly (Pre-Load)

**B. Determine shim(s) requirements. See** Figure 7015**.**

(1) Put spacer (350) (Models 23080-002, 23080-004, 23080-056 and 23080-058) or DE bearing shield (Models 23080-023, 23080-023A, 23080-023B, 23080-059, 23291-005, 23291-006, 23291-007) on the drive end of armature (500) shaft with the part identification stamping facing inboard.

(2) Measure and record the distance from the mounting surface of the bearing and brush support assembly (320) to the top surface of the spacer or DE bearing shield (350) on armature shaft. Record as dimension ‘A’.

(3) Measure and record the distance from the mounting surface of the stator and housing assembly (540) to the bottom of the bearing liner in drive end bearing support assembly (400). Record as dimension ‘B’.

(4) Subtract dimension 'B' from dimension 'A' and record difference. The difference is the gap without shims.

NOTE: The calculated difference between dimensions 'A' and 'B' is the gap for the spring wave washer (460). The desired gap for the compressed spring wave washer is as follows:

| | |
|---|---|
| All models | 0.030 to 0.041 inch (0,76 to 1,04 mm) |

(5) If required, make a shim pack with enough shims (470, 480, 490) to reduce the gap to between 0.030 to 0.041 inch (0,76 to 1,04 mm).

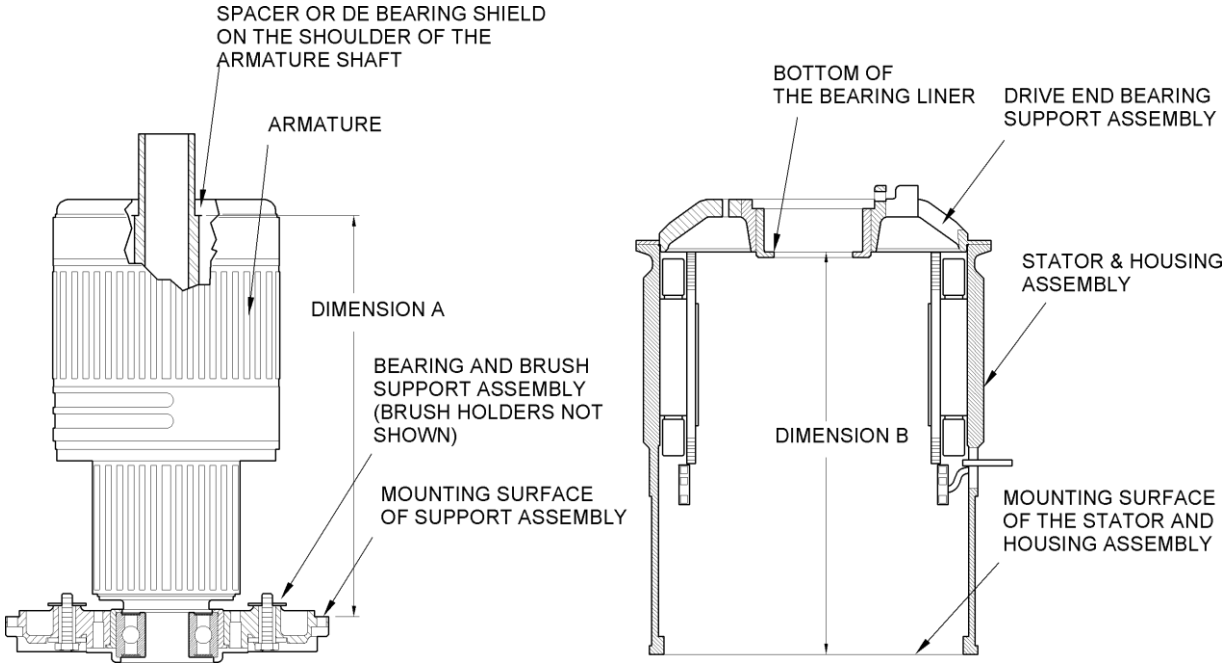


Figure 7015 - Determining Shim Requirements (Pre-Load)

**C. Installing the shim(s) (470, 480, 490) (if required), spring wave washer (460) and drive end ball bearing (450). See Figure 7016.**

(1) Place the stator and housing assembly (540) vertical on the arbor press table with the drive end up.

(2) Put the shim(s) (470, 480, 490) (if required) into the bottom of the bearing liner in the drive end bearing support assembly (400).

(3) Put the spring wave washer (460) in the bearing liner on top of the shim(s) (if present).

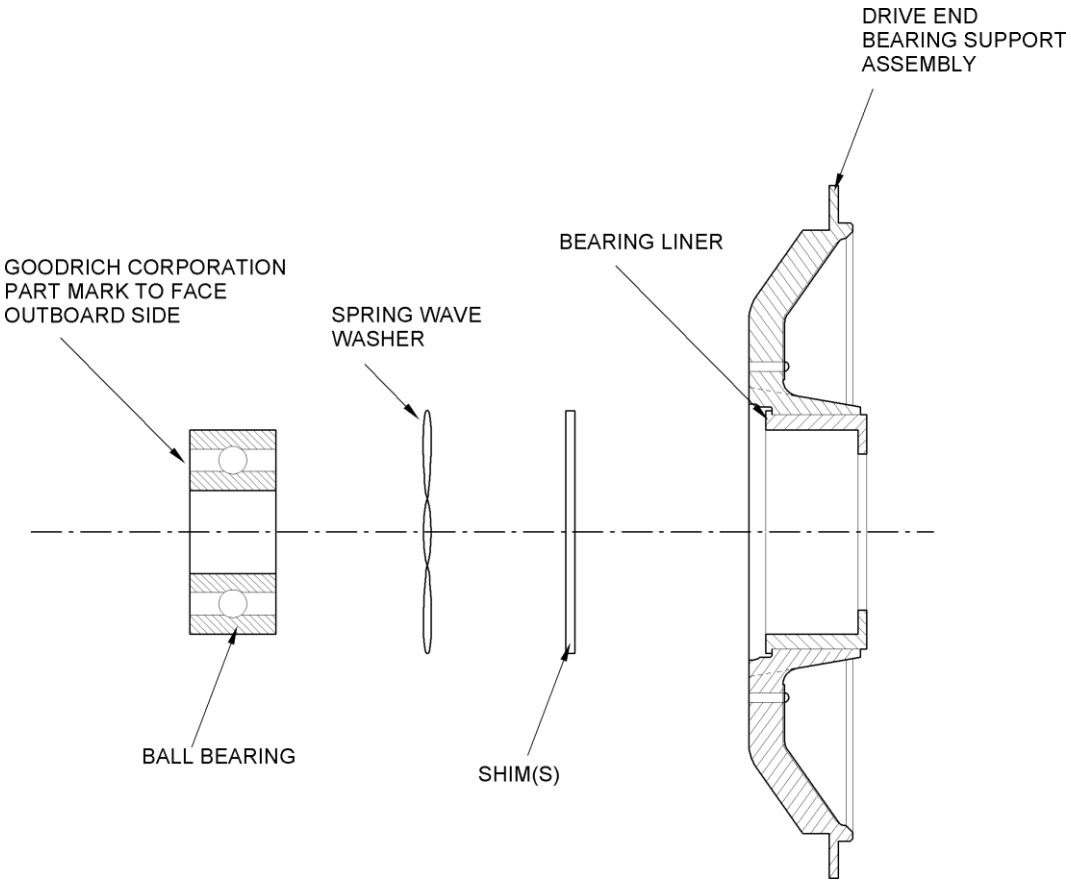


Figure 7016 - Spring Loaded Assembly, Sectional View (Pre-Load)

**WARNING: DO NOT LET PASTE TOUCH THE EYES OR SKIN. OBEY THE MANUFACTURER'S INSTRUCTIONS. REFER TO MSDS SHEET BEFORE PASTE IS USED.**

(4) Apply lubricating and assembly paste to the inside diameter of the bearing liner.

(5) Lightly press a drive end ball bearing (450) into the drive end bearing support assembly (400) using an outer race bearing driver.

NOTE: The Safran Power part marking on the ball bearing (450) must be facing towards the outside of the starter-generator.

**D. Assemble the bearing and brush support assembly (320), with attached armature (500), to the stator and housing assembly (540). See Figure 7017.**

(1) Set vertical shaft support on arbor press table.

(2) Set stator and housing assembly (540) with attached drive end bearing support assembly (400) (drive end down) onto vertical shaft support.

(3) Insert armature (500) with attached bearing and brush support assembly (320) into stator and housing assembly (540).

NOTE: Make sure the spacer or DE bearing shield (350) is still on the armature (500) shaft.

(4) Align four brush harness straps with brush holder assemblies. If necessary, use a probe to move brush harness straps to correct positions.

(5) Set inner race bearing driver onto anti-drive end ball bearing (530).

(6) Press armature (500) shaft into drive end bearing (450). Make sure that screw holes in bearing and brush support assembly (320) are correctly aligned with mounting holes in stator and housing assembly (540). Make sure that bearing and brush support assembly is properly installed against stator and housing assembly (540).

(7) Put a flat washer (340) onto each of the eight self-locking screws (330).

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(8) Apply thread sealing compound to threads of screws (330).

(9) Attach bearing and brush support assembly (320) to stator and housing assembly (540) with eight attaching screws (330). Tighten screws (330) to a torque of 13.5 to 18.0 lbf.in. (1,53 to 2,03 N·m).

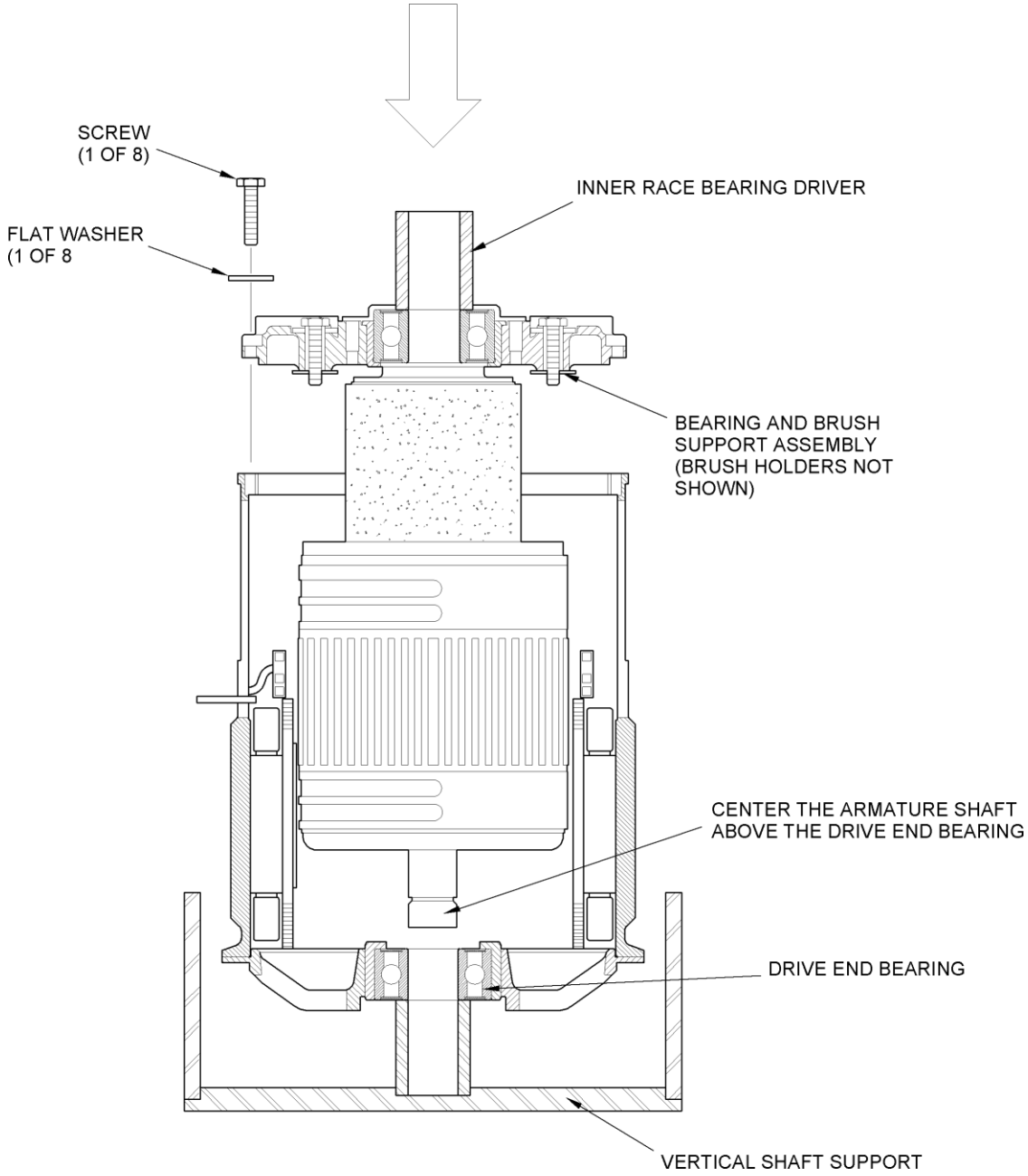


Figure 7017 - Pressing the Bearing and Brush Support Assembly with Attached Armature into the Stator and Housing Assembly (Pre-Load)

**E. Installing speed pickup gear (310) or shaft spacer (-430) and retaining ring (300) onto armature (500) shaft. See Figure 7018.**

(1) For all models except 23080-056, slide the speed pickup gear (310) on the armature (500) shaft. The inner rim on the speed pickup gear (310) faces the drive end bearing (450). See Figure 7018.

(2) For model 23080-056, slide shaft spacer (-430) onto the drive end of the armature (500) shaft.

(3) Install a new retaining ring (300) into the groove of the armature (500) shaft. Make sure retaining ring is fully installed.

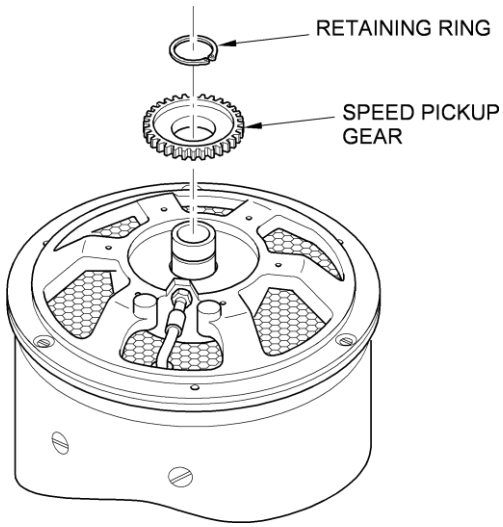


Figure 7018 - Installing Speed Pickup Gear and Retaining Ring onto Armature Shaft (Pre-Load)

## 10. Final Assembly of the DC Starter-Generator

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10001 of the ILLUSTRATED PARTS LIST.

**A. For all models except 23080-056, attach thermal switch (390) to stator and housing assembly (540).**

**WARNING: DO NOT GET LOCTITE GRADE A ON YOUR SKIN. IF YOU GET SOME ON YOUR SKIN, FLUSH WITH CLEAN WATER. REFER TO THE APPLICABLE MATERIAL SAFETY DATA SHEET FOR MORE INFORMATION.**

**WARNING: THREAD LOCKING ADHESIVE IS HIGHLY FLAMMABLE AND TOXIC. DO NOT USE NEAR OPEN FLAMES OR SPARKS. USE IN A WELL-VENTILATED AREA.**

(1) Apply Loctite, Grade A, to internal thread of tapped hole in stator and housing assembly (540).

(2) Thread thermal switch (390) into hole in stator and housing assembly (540).

**B. Attach spacer (370) and 3-pin connector (360) to stator and housing assembly (540), all models except 23080-056. See Figure 7019.**

NOTE: Allow enough lead length to reach through spacer.

(1) Cut to length and strip leads from speed pickup (420) and thermal switch (390) (if applicable).

(2) Slide a sufficient length of insulating sleeving over the speed pickup and thermal switch leads to cover the soldered location.

(3) Solder connector pin on each of three leads.

NOTE: All soldering procedures must be done to ANSI/IPC J-STD-001.

(4) Apply heat to the insulating sleeving over the soldered pins to shrink sleeving in place with a heat gun.

NOTE: When properly installed, the slot in the spacer (370) will be against the stator and housing assembly (540). The speed pickup leads route through the slot in the spacer. The open area of the spacer will be over the thermal switch (390).

(5) Thread speed pickup leads and thermal switch lead through spacer (370).

(6) Place pickup wires in clamp (60). Attach clamp to stator and housing assembly (540) with screw (70). Tighten the screw to a torque of 13.5 to 18.0 lbf.in. (1,5 to 2.0 N·m).

(7) Carefully coil wires around connector to avoid pressing against thermal switch.

(8) Position the 3-pin connector (360) on spacer (370).

NOTE: Position polarizing key of 3-pin connector as shown (see Figure 7020).

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(9) Apply thread sealing compound to threads of four screws (380).

(10) Attach spacer (370) and connector (360) to the stator and housing assembly (540) using four screws (380). Tighten the screws to a torque of 4.2 to 5.5 lbf.in. (0,47 to 0,62 N·m).

(11) Check for continuity between speed pickup connector pins.

(12) Lockwire the four screws (380) and screw (70) with lockwire (MS20995C20) IAW MS33540.

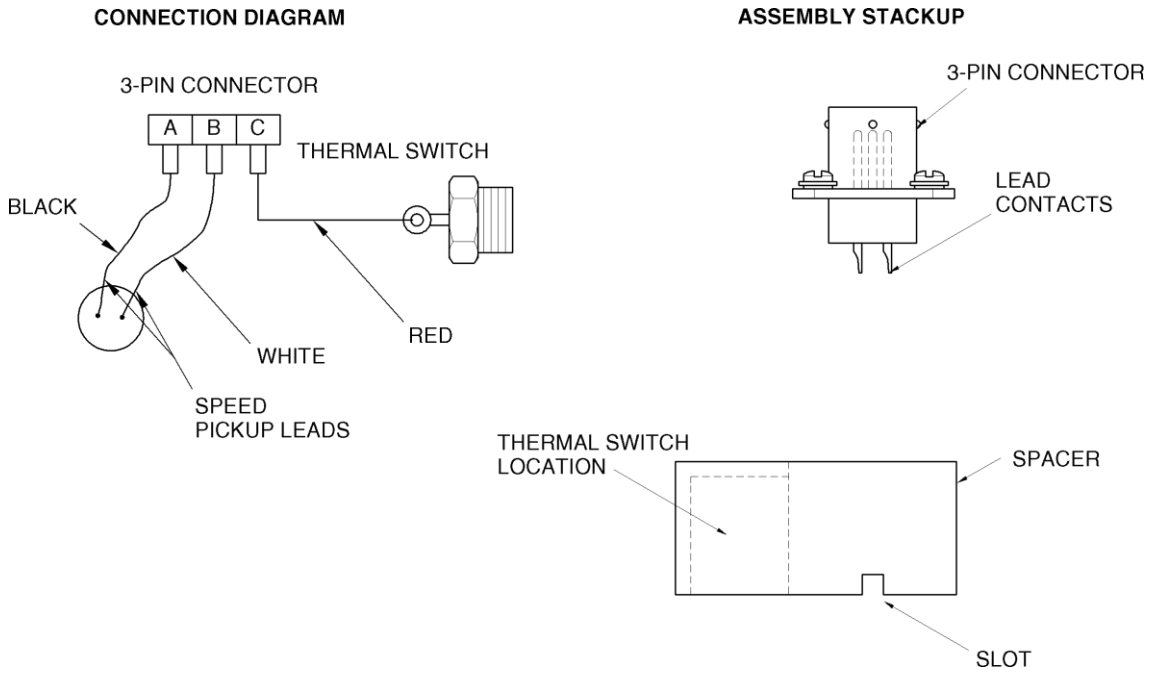



Figure 7019 - Assembling the 3-Pin Connector and Spacer

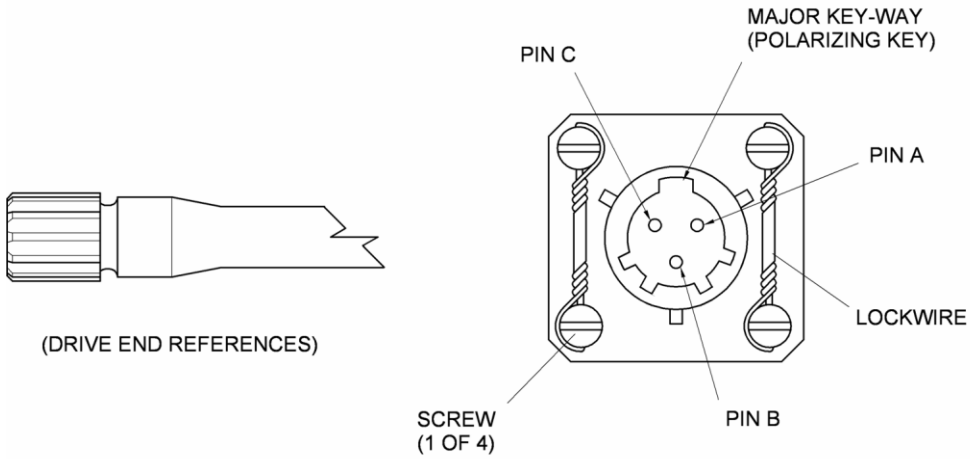



Figure 7020 - Orientation of 3-Pin Connector

**C. Installing dampener backplate (290) and friction ring (260) onto armature (500) shaft. See Figure 7021.**

(1) Set stator and housing assembly (540) on horizontal stator support.

(2) Twist dampener backplate (290) onto drive end of armature shaft until fully installed.

(3) Put friction ring (260) into recess of dampener backplate.

NOTE: Friction ring (260) may not stay in place until drive shaft (240) with attached dampener plate (270) is installed.

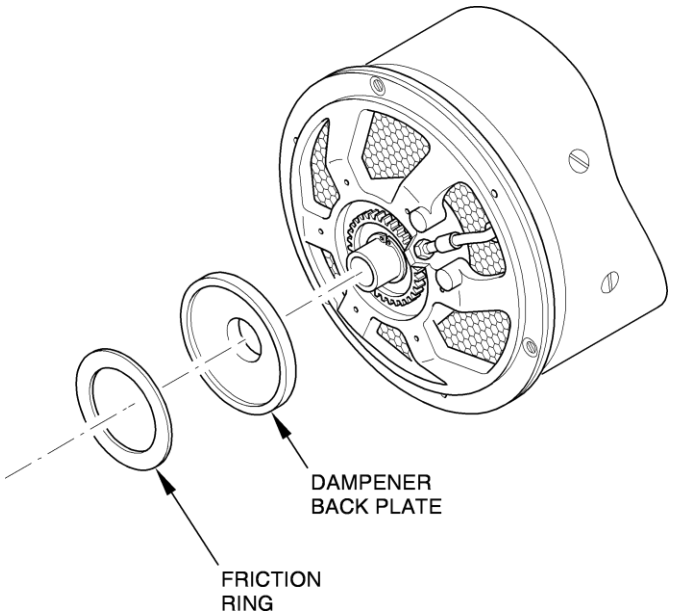



Figure 7021 - Installing Dampener BackPlate and Friction Ring

**D. Assemble dampener hub (280) and dampener plate (270) on drive shaft (240). See Figure 7022.**

**CAUTION:** DO NOT FORCE DAMPENER HUB ON DRIVE SHAFT MATING TAPER. TOO MUCH FORCE CAN CAUSE THE DAMPENER HUB TO FRACTURE.

(1) Press dampener hub (280) on drive shaft (240) if it was removed.

(2) Put drive shaft (240) and dampener hub (280) through dampener plate (270) and dampener plate driver. Align splines.

(3) Using a leather or plastic mallet, lightly tap drive end of drive shaft to install dampener plate on dampener hub.

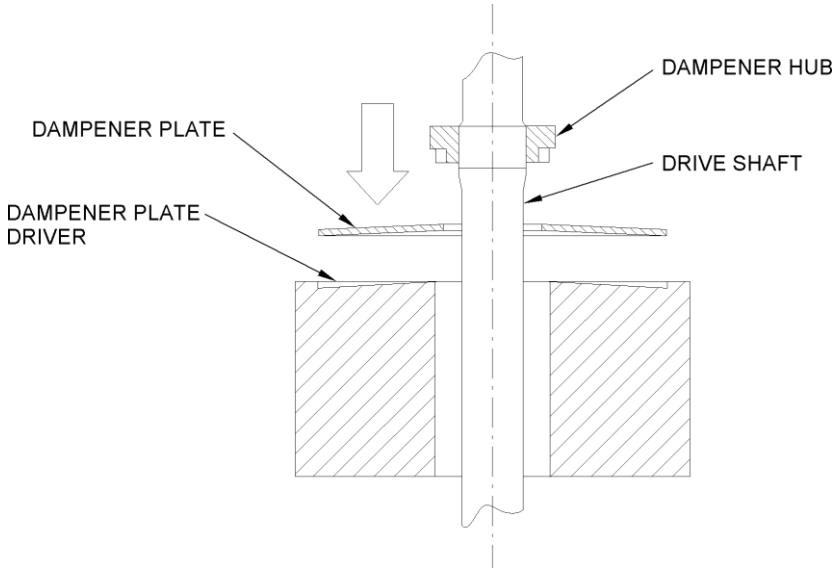



Figure 7022 - Dampener Plate and Driver

**E. Insert drive shaft (240) in armature (500) shaft. See Figure 7023.**

**CAUTION:** DO NOT USE HIGH FORCE TO ENGAGE THE DRIVE SHAFT AND ARMATURE SHAFT MATING SPLINES. FAILURE TO CORRECTLY ENGAGE THE SPLINES CAN CAUSE DAMAGE TO THE DRIVE SHAFT AND ARMATURE SHAFT.

(1) Insert drive shaft (240) in drive end of armature (500) shaft.

(2) Push drive shaft (240) through armature (500) shaft until dampener plate (270) is fully installed against friction ring (260).

(3) Turn drive shaft (240) in direction of rotation (counterclockwise facing the drive end) to make sure that armature (500) shaft and drive shaft tapered spline is installed into the spline in the armature shaft.

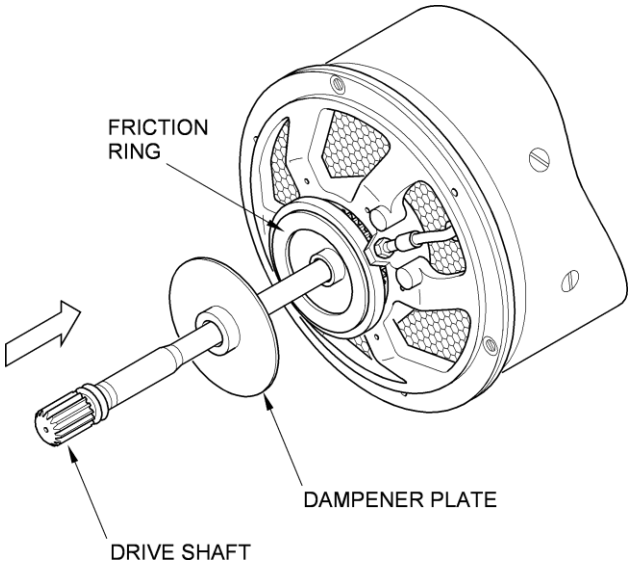



Figure 7023 - Installing Drive Shaft into Armature Shaft

**F. Attach anti-drive end bearing shield (550) and fan (210) to drive shaft. See** Figure 7024**.**

(1) For models 23080-023, 23080-023A, 23080-023B, 23080-059, 23291-005, 23291-006 and 23291-007 put anti-drive end bearing shield (550) on drive shaft (240) with part markings facing fan.

(2) Put fan (210) on drive shaft (240).

(3) Attach fan (210) to drive shaft with a flat washer (230) and a self-locking nut (220).

(4) Use a spline wrench to hold the drive shaft (240) in place. Tighten self-locking nut (220) to a torque of 100 to 120 lbf.in. (11,3 to 13,6 N·m).

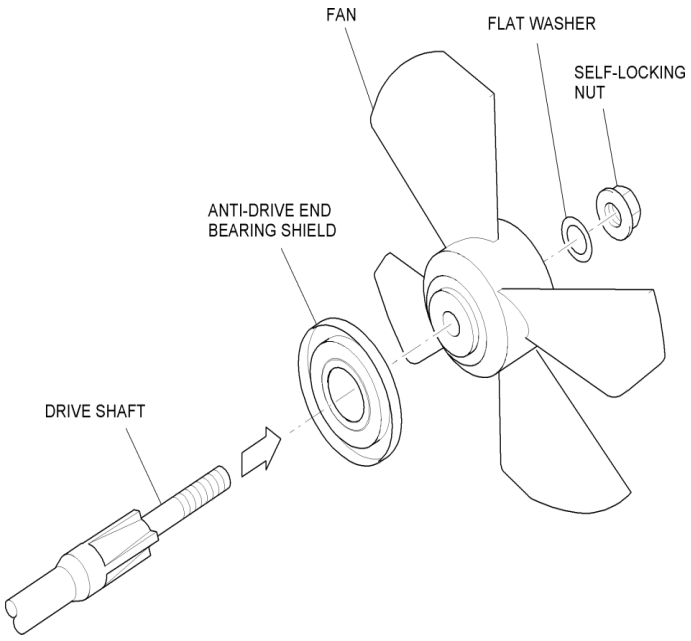



Figure 7024 - Installing the Fan

**G. Install the brushes (190).**

NOTE: If new brushes (190) are to be used, identify the brushes with the numbers 1 through 4.

**CAUTION:** RAISE AND LOWER BRUSH SPRINGS SLOWLY. DO NOT LIFT BRUSH SPRINGS MORE THAN NEEDED TO INSERT BRUSH SETS INTO BRUSH HOLDER ASSEMBLY.

(1) Set starter-generator, anti-drive end up, onto a vertical stator support.

(2) At each brush holder location, lift one brush spring at a time with a wire hook tool and insert brush set into a brush holder assembly.

(3) Slowly lower springs on top of brushes. Make sure that brush leads are not caught under brush springs.

(4) Install four electrical brushes (190) into the corresponding complete brush holders (10002-30).

(5) Secure the four brush (190) leads and four braided stator leads to complete brush holders (10002-30) with four screws (200) to a torque of 25.0 to 35.0 lbf.in. (2,8 to 4,0 N·m). Make sure leads are arranged over brush springs (10002-130) to prevent brushes (190) from hanging up.

**H. Coarse seat the new brushes (190).**

(1) Coarse seat the brushes (190) IAW SPD 1006.

NOTE: The sandpaper should first touch the leading edge (short side) of the brush (190) when the armature (500) is rotated in its normal direction.

(2) Remove any remaining sandpaper IAW SPD 1006 when done with brush run-in.

**I. Perform brush (190) run-in.**

**CAUTION:** FAILURE TO FULLY SEAT THE BRUSHES CAN DECREASE BRUSH LIFE, LOWER STARTER- GENERATOR PERFORMANCE, OR CAUSE STARTER-GENERATOR FAILURE.

**CAUTION:** DO NOT LET THE STARTER-GENERATOR HANG UNSUPPORTED DURING INSTALLATION ONTO AND REMOVAL FROM THE DRIVE STAND. TOO MUCH LOAD ON THE DRIVE SHAFT SHEAR SECTION CAN DAMAGE THE UNIT.

(1) Run-in the brushes (190) IAW SPD 1006.

NOTE: A correctly seated brush (190) has a smooth and semi-gloss contact surface.

**J. Form the brush leads.**

**CAUTION:** FAILURE TO PROPERLY FORM THE BRUSH LEAD CAN RESULT IN BRUSH HANG UP.

(1) Form the brush leads IAW SPD 1006.

**K. Install brush access cover (160).**

**CAUTION:** THE JOINT FORMED BY THE BRUSH ACCESS COVER MUST NOT BE POSITIONED OVER AN ACCESS WINDOW IN THE HOUSING. THE BRUSH SHUNT WIRES CAN SHORT TO THIS AREA.

(1) Install brush access cover (160) on bearing and brush support assembly (320).

(2) Tighten screw (170) to a torque of 25.0 to 35.0 lbf.in. (2,8 to 4,0 N·m).

NOTE: Brush access cover (160) will be removed for acceptance testing and replaced after acceptance testing.

NOTE: Anti-seize compound (Never-Seez) must be applied to the screw (170) after acceptance test is finished during final assembly per Paragraph 12.D.

**L. Install air inlet (100) on models 23080-002, 23080-023, 23080-023A, 23080-023B, 23080-059, 23291-005, 23291-006 and 23291-007.**

(1) Using a vertical stator support, place stator and housing assembly (540), fan (210) up, on a work bench.

**WARNING:** **THREAD SEALING COMPOUND IS DANGEROUS TO PERSONS. USE ONLY IN AN AREA WITH A GOOD FLOW OF AIR. KEEP AWAY FROM SOURCES OF HEAT, SPARKS AND FLAME. DO NOT BREATHE THE FUMES. PREVENT SKIN CONTACT. PUT ON PROTECTIVE CLOTHING AND EYE PROTECTION.**

(2) Apply thread sealing compound to threads of four screws (110).

(3) Position air inlet (100) covering bearing and brush support (320) and secure with four screws (110) to a torque of 9.0 to 12.0 lbf.in. (1,0 to 1,4 N·m).

(4) After acceptance testing, lockwire (MS20995C32) the four attaching screws (110) IAW MS33540.

NOTE: Do not attach lockwire to screws until after acceptance testing.

**M. Install fan shroud (130) and air inlet (100) on models 23080-004 and -056.**

(1) Using a vertical stator support, place stator and housing assembly (540), fan (210) up on a work bench.

(2) Place a flat washer (150) onto each of the four screws (140).

**WARNING:** **THREAD SEALING COMPOUND IS DANGEROUS TO PERSONS. USE ONLY IN AN AREA WITH A GOOD FLOW OF AIR. KEEP AWAY FROM SOURCES OF HEAT, SPARKS AND FLAME. DO NOT BREATHE THE FUMES. PREVENT SKIN CONTACT. PUT ON PROTECTIVE CLOTHING AND EYE PROTECTION.**

(3) Apply thread sealing compound to threads of four screws (140).

(4) Position fan shroud (130) covering bearing and brush support (320) and secure with four screws (140) to a torque of 9.0 to 12.0 lbf.in (1,0 to 1,4 N·m).

(5) After acceptance testing, lockwire (MS20995C32) the four attaching screws (140) IAW MS33540.

(6) Place air inlet (100) on fan shroud (130) in position shown in Figure 7025.

(7) Attach the air inlet (100) to the fan shroud (130) with five screws (110). Tighten the screws (110) to a torque of 13.5 to 18.0 lbf.in (1,5 to 2,0 N·m).

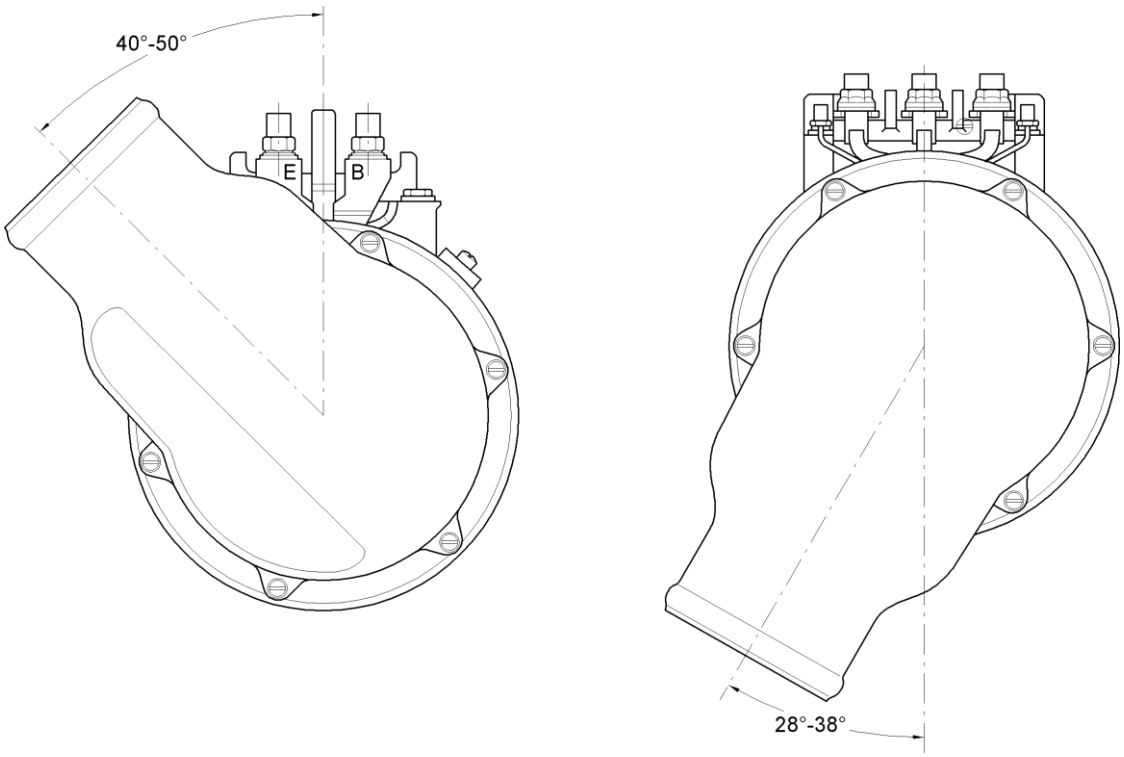



Figure 7025 - Angular Position of Air Inlets

**N. Install TSO label (-50) and patent label (-40), if required.**

**WARNING: ISOPROPYL ALCOHOL IS DANGEROUS TO PERSONS. USE ONLY IN AN AREA WITH A GOOD FLOW OF AIR. KEEP AWAY FROM SOURCES OF IGNITION. DO NOT BREATHE THE FUMES. PREVENT SKIN CONTACT. PUT ON PROTECTIVE CLOTHING AND EYE PROTECTION.**

(1) Clean stator and housing assembly (540) surface adjacent to the identification plate (10), where label is to be applied, using isopropyl alcohol and a clean, lint-free cloth.

(2) Allow the isopropyl alcohol to dry.

(3) Remove the protective backing on the TSO label (-50) and/or patent label (-40) and install label on stator and housing assembly (540).

**O. Install caution decal (30) if required.**

**WARNING: ISOPROPYL ALCOHOL IS DANGEROUS TO PERSONS. USE ONLY IN AN AREA WITH A GOOD FLOW OF AIR. KEEP AWAY FROM SOURCES OF IGNITION. DO NOT BREATHE THE FUMES. PREVENT SKIN CONTACT. PUT ON PROTECTIVE CLOTHING AND EYE PROTECTION.**

(1) Clean stator and housing assembly (540) surface, opposite side of terminal block from identification plate (10), where decal is to be applied using isopropyl alcohol and a clean, lint-free cloth.

(2) Allow the isopropyl alcohol to dry.

(3) Remove the protective backing on the caution decal (30) and install decal on stator and housing assembly (540).

**P. Install replacement identification plate (10), if required.**

(1) Transfer information from old identification plate to replacement to identification plate.

(2) Position replacement identification plate on stator and housing assembly (540) and secure with four drive screws (20).

**WARNING: KEEP ACRYLIC COATING AWAY FROM SOURCES OF HEAT, SPARKS AND FLAME. CONFORMAL COATING IS FLAMMABLE.**

**WARNING: DO NOT GET ACRYLIC COATING ON YOUR SKIN AND DO NOT BREATHE THE FUMES. ACRYLIC COATING IS A POISONOUS MATERIAL.**

(3) Coat the replacement identification plate (10) with acrylic coating and let the coating air dry.

**Q. Attach serviceable terminal block (80) to housing.**

(1) Remove unserviceable terminal block from housing. Refer to DISASSEMBLY section.

NOTE: Only applicable if a dummy terminal block is used during acceptance testing. Refer to TESTING AND FAULT ISOLATION section.

(2) Set unit on horizontal stator support.

**CAUTION:** DO NOT BEND THE LARGE STATOR LEADS MORE THAN NECESSARY TO INSTALL THE TERMINAL BLOCK.

**CAUTION:** AS TERMINAL BLOCK IS GENTLY PUSHED INTO PLACE, MAKE SURE THAT TERMINAL LEADS A AND D ARE NOT UNDERNEATH TERMINAL BLOCK.

(3) Set terminal block (80) on housing and gently push terminal block into position on larger stator leads B and E.

(4) Put the small stator lead terminal lugs (130) on studs A and D.

NOTE: For all models except 23080-056, place leads to terminal studs A and D in grooves in the terminal block (80).

(5) For all models except 23080-056:

(a) Put a tab-lock washer (100) and insulation (110) onto each of the two bolts (90).

(b) Put a tab-lock washer (70) on bolt (60).

(c) Put the two bolts (90) into the corner holes of the terminal block (80) and tighten the bolts to a torque of 25.0 to 30.0 lbf.in. (2,8 to 3,4 N·m).

(d) Put bolt (60) into the centre hole on the terminal block (80) and tighten the bolt to a torque of 31.5 to 42.0 lbf.in (3,6 to 4,7 N·m).

(e) Bend the tabs on tab-lock washers (70) and (100) into place.

(6) For model 23080-056:

(a) Put a lock washer (100) and flat washer (120) onto each of the two bolts (90).

(b) Put the two bolts (90) into the holes of the terminal block (80) and tighten two bolts (90) to a torque of 7.7 to 10.3 lbf.in. (0,87 to 1,16 N·m).

## 11. Perform Acceptance Test on Starter-Generator

**CAUTION:** BEFORE ACCEPTANCE TESTING, ATTACH AN UNSERVICEABLE TERMINAL BLOCK (10004-80) TO THE STATOR AND HOUSING ASSEMBLY (540).

Perform acceptance test procedure on the assembled starter-generator as detailed in the TESTING AND FAULT ISOLATION section.

NOTE: Acceptance testing of the starter-generator after assembly is optional.

## 12. Final Assembly after Acceptance Testing

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers in Figure 10001 of the ILLUSTRATED PARTS LIST.

### A. Install terminal block hardware.

(1) Secure stator lead to terminals A and D with self-locking nut (30) and flat washer (40) at each location.

(2) At terminals B and E install a flat washer (20) and self-locking nut (10).

NOTE: Do not tighten the nuts (10) and (30) on terminal block studs A, D, B and E. They will be tightened at the time of installation into the aircraft.

(3) If the terminal block grounding lead was disconnected and taped, remove the tape and secure the grounding lead with screw (560) and flat washer (570).

**B. Attach terminal block cover (80) (if present).**

NOTE: When a starter-generator is removed from aircraft for service, the terminal block cover usually stays on the aircraft.

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers given in Figure 10001 of the ILLUSTRATED PARTS LIST.

For model 23080-056, attach terminal block cover (80) to the terminal block (10004-80) with two screws (90). Tighten the screws (90) to a torque of 7.7 to 10.3 lbf.in (0,87 to 1,19 N·m).

**C. Remove commutation viewing adapter.**

Unthread the screw (170) from self-locking blind rivet nut that secures commutation viewing adapter to starter-generator. Remove the commutation viewing adapter.

**D. Attach brush access cover (160).**

**WARNING: ANTI-SEIZE COMPOUND IS FLAMMABLE. DO NOT USE NEAR OPEN FLAMES, NEAR WELDING AREAS, OR ON HOT SURFACES.**

(1) Apply anti-seize compound (Never-Seez) to the threads of self-locking blind rivet nut (180).

(2) Install the screw (170) into self-locking blind rivet nut (180).

(3) Position brush access cover (160) around stator and housing assembly (540).

**CAUTION:** THE JOINT FORMED BY THE BRUSH ACCESS COVER MUST NOT BE POSITIONED OVER AN ACCESS WINDOW IN THE HOUSING.

(4) Thread screw (170) into self-locking blind rivet nut. Tighten screw to a torque of 25.0 to 35.0 lbf.in. (2,8 to 4,0 N·m).

**E. Lockwire screws (110, 140) that attach air inlet (100) or fan shroud (130) to starter-generator.**

Lockwire the four screws (110) that attach air inlet to starter-generator or four screws (140) and four washers (150) that attach fan shroud to starter generator with Lockwire P/N MS20995C32 IAW MS33540.

**F. Attach QAD kit to starter-generator (when applicable).**

(1) Put V-retainer coupling (10005-10) over drive end bearing support assembly.

(2) Put adapter and seal assembly (10005-40) in inner rim of V-retainer coupling (10005-10) and engage QAD adapter's alignment pins (10005-60) in mating holes in drive end bearing support assembly (400).

(3) Torque self-locking nut (10005-20) on T-bolt (10005-30) to 70 lbf.in. (7,9 N·m).

## 13. Preparation for Shipment/Storage

Refer to STORAGE section for shipment/storage instructions.

## 14. Package the Starter-Generator for Shipment or Storage

Coat drive spline with grease and wrap the drive spline with protective paper according to MIL-B-121A, Grade A, Type II, Class 1.

For shipment or storage, seal starter-generator unit in suitable plastic container to protect against corrosion and airborne contaminants. Refer to STORAGE section in this manual for packing materials.

# FITS AND CLEARANCES

## 1. Introduction

A. The following paragraphs provide information for determining the acceptability of fits and clearances of the starter-generator.

B. Examine the parts for damage. Refer to CHECK section, for details.

C. Repair the parts before assembly. Refer to REPAIR section, for details.

D. The acceptance limits for starter-generator components and subassemblies are listed in Paragraph 2.

E. The required torque values to be used during repair and assembly of starter-generator components and attaching parts are listed in Paragraph 3.

## 2. Component Acceptance Limits

Refer to Table 8001 for starter-generator component and subassembly acceptance limits. Paragraph designations in the CHECK column refer to the applicable inspection procedure found in the CHECK section.

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers on the figure of ILLUSTRATED PARTS LIST.

| CHECK Para. Ref. | Nomenclature and IPL Number | Inspect for… | Acceptance Limits |
|---|---|---|---|
| 8.B. | Mounting Adapter (10005-50) | Guide pin height (10005-60)<br>23080-002<br>23080-004<br>23080-023<br>23080-023A<br>23080-023B<br>23080-058<br>23291-005 | 0.14 to 0.16 inch (3,56 to 4,06 mm) |
| | | 23080-056 | 0.18 to 0.20 inch (4,57 to 5,08 mm) |
| | | 23080-059<br>23291-006<br>23291-007 | Part has no guide pin. |

Table 8001 - Acceptance Limits

| CHECK Para. Ref. | Nomenclature and IPL Number | Inspect for… | Acceptance Limits |
|---|---|---|---|
| 8.J. | Drive Shaft (10001-240) | Spline diameter<br><br>23080-002<br>23080-004<br>23080-023<br>23080-023A<br>23080-023B<br>23080-058<br>23080-059<br>23291-005<br>23280-067<br>23280-075 | 0.921 inch (23,39 mm) min. over two 0.096 inch (2,44 mm) dia pins. |
| | | Spline diameter<br><br>23080-056 | 0.757 inch (19,23 mm) min. over two 0.1094 inch (2,779 mm) dia pins. |
| 8.K. | Friction Ring (10001-260) | Thickness | 0.060 inch (1,52 mm) min. |
| 8.L. | Dampener Plate (10001-270) | Thickness | 0.038 inch (0,96 mm) min. |
| | | Internal spline diameter | Gage pin dia:<br>0.090 inch (2,29 mm)<br>Distance between two pins:<br>0.655 inch (16,637 mm) max. |
| 8.O. | Bearing and Brush Support Assembly (10001-320) | Bearing liner diameter | 1.8501 to 1.8504 inch (46,992 to 47,000 mm)<br>See Figure 8002. |
| 8.O.(8) | Brush Spring (10002-130) | Force | Position “A”<br>3.28 lb (1,5 kg) min.<br>Position “B”<br>4.00 lb (1,8 kg) max. |
| 8.R. | Thermal Switch (10001-390) | Actuation | When the temperature rises to 330 ± 8° F (161,1 to 170° C) the switch closes, and reopens at 300 ± 8° F (144,4 to 153,3° C). |
| 8.S. | Drive End Bearing Support Assembly (10001-400) | Bearing liner diameter | 1.8501 to 1.8504 inch (46,992 to 47,002 mm)<br>See Figure 8002. |

Table 8001 - Acceptance Limits (Continued)

| CHECK Para. Ref. | Nomenclature and IPL Number | Inspect for… | Acceptance Limits |
|---|---|---|---|
| 8.T. | Speed Pickup (10001-420) | Resistance, lead to ground | More than 1 MΛ |
| | | P/N 23072-1400 Resistance between leads | 20 to 45 Λ |
| | | P/N 23072-1280 Resistance between leads | 95 to 137 Λ |
| 8.V. | Armature (10001-500) | Bearing Journal Diameter (A, C) | 0.7872 to 0.7875 inch (19,995 to 20,003 mm). See Figure 8001. |
| | | Commutator Diameter (B) | 2.500 inch (63,50 mm) Min. |
| | | Mica Undercut (before recut) | Depth: 0.045 inch (1,143 mm) min. to 0.070 inch (1,780 mm) max. Width: 0.035 inch (0,889 mm) to 0.045 inch (1,142 mm). |
| | | Mica Undercut (after recut) | Depth: 0.050 inch (1,270 mm) min. to 0.070 inch (1,780 mm) max. Width: 0.035 inch (0,889 mm) to 0.045 inch (1,142 mm). |
| | | Commutator bar to bar acceptance test values | Bar to Bar: 0.0002 inch (0,005 mm) max. T.I.R: 0.0008 inch (0,020 mm) max. |
| | | Commutator bar to bar (Before refinishing) | Bar to Bar: 0.0008 inch (0,020 mm) max. |
| | | Commutator bar to bar and concentricity (After refinishing) | Bar to Bar: 0.0001 inch (0,0025 mm) max. T.I.R: 0.0005 inch (0,0127 mm) max. |
| | | Balance | 5 grain inch (8,2 gr mm) max. (each end). |
| 8.Z. | Terminal Block (10004-80) | Capacitance values: B to E and B to ground | 1.8 to 2.2 µFd<br><br>Tested @ 110 to 130 Hz, 77° F (25° C) ± 10% |

Table 8001 - Acceptance Limits (Continued)

## 3. Torque Values

NOTE: Unless otherwise specified, numbers in parentheses ( ) refer to item numbers on the figure of ILLUSTRATED PARTS LIST.

Table 8002 gives information necessary to tighten fasteners to specified torque. Values shown do not include frictional torque caused by self-locking devices or rundown resistance. Frictional torque values must be added to the specified torque.

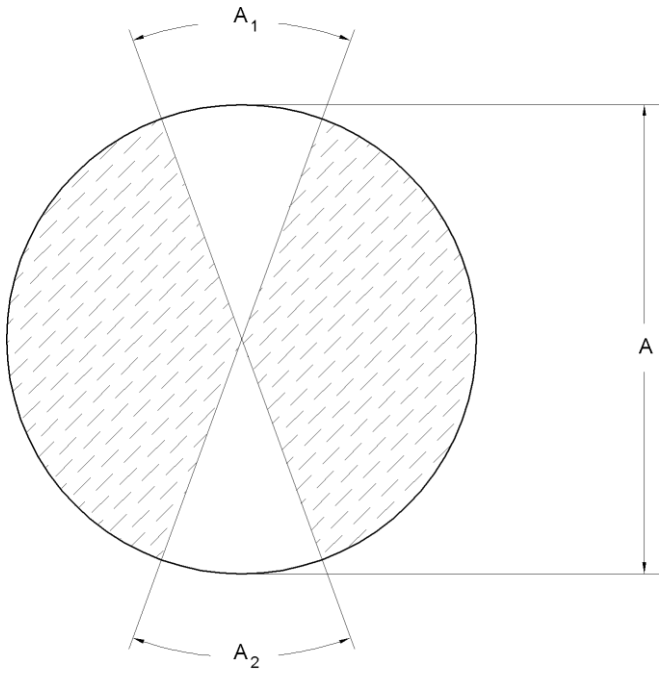
Nuts, bolts, and screws not listed in Table 8002 are to be tightened in accordance with Safran Power methods and techniques or practices acceptable to your administration as specified in FAR PART 43.

| Hardware Description | Torque Acceptance Limits |
|---|---|
| Fillister Head Screw (10001-70) | 13.5 to 18.0 lbf.in. (1,53 to 2,03 N·m) |
| Screw (10001-90) | 7.7 to 10.3 lbf.in. (0,87 to 1,19 N·m) |
| Fillister Head Screw (10001-110) Models 23080-002, 23080-023, 23080-023A, 23080-023B, 23080-058, 23080-059, 23291-005, 23291-006 and 23291-007 | 9.0 to 12.0 lbf.in. (1,0 to 1,4 N·m) |
| Fillister Head Screw (10001-110) Models 23080-004 and 23080-056 | 13.5 to 18.0 lbf.in. (1,53 to 2,03 N·m) |
| Fillister Head Screw (10001-140) | 9.0 to 12.0 lbf.in. (1,0 to 1,4 N·m) |
| Fillister Head Screw (10001-170) | 25.0 to 35.0 lbf.in. (2,8 to 4,0 N·m) |
| Screw (10001-200) | 25.0 to 35.0 lbf.in. (2,8 to 4,0 N·m) |
| Self-locking Nut (10001-220) | 100 to 120 lbf.in. (11,3 to 13,6 N·m) |
| Self-locking Screw (10001-330) | 13.5 to 18.0 lbf.in. (1,53 to 2,03 N·m) |
| Screw (10001-380) | 4.2 to 5.5 lbf.in. (0,47 to 0,62 N·m) |
| Screw (10001-410) | 7.7 to 10.3 lbf.in. (0,87 to 1,16 N·m) |
| Jam Nut (Part of Speed Pickup) (10001-420) | 15.0 to 25.0 lbf.in. (1,7 to 2,8 N·m) |
| Screw (10001-520) | 13.5 to 18.0 lbf.in. (1,53 to 2,03 N·m) |
| Machine Bolt (10002-50) | 25.0 to 30.0 lbf.in. (2,8 to 3,4 N·m) |
| Stud (10004-50) | 300 to 325 lbf.in (33,9 to 36,7 N·m) |
| Bolt (10004-60) | 31.5 to 42.0 lbf.in (3,6 to 4,7 N·m) |
| Machine Bolt (10004-90) Models 23080-002, 23080-004, 23080-023, 23080-023A, 23080-023B, 23080-058, 23080-059, 23291-005 23291-006 and 23291-007 | 25.0 to 30.0 lbf.in. (2,8 to 3,4 N·m) |

Table 8002 - Torque Values

| Hardware Description | Torque Acceptance Limits |
|---|---|
| Screw (10004-90)<br>Model 23080-056 | 7.7 to 10.3 lbf.in (0,87 to 1,16 N·m) |
| Self-locking Nut (10005-20) | 70 lbf.in. (7,9 N·m) |

Table 8002 - Torque Values (Continued)




A1 + A2 < 25% OF DIAMETER A MINIMUM

Figure 8001 - Measuring Armature Bearing Journal Diameters

NOTE: During overhaul/service inspection, diameter of bearing journal is considered to be acceptable if not more than 25% of circumference is below the minimum diameter limit (See Figure 8001). When the starter-generator is to be repaired and returned to service on a “continued time” basis, the minimum diameter limit of bearing journal diameter “A” is acceptable if up to 25% of the circumference is not more than 0.0001 inch (0,0025 mm) below minimum diameter limit.

NOTE: Acceptance criteria for used journals, not new or repaired journals.

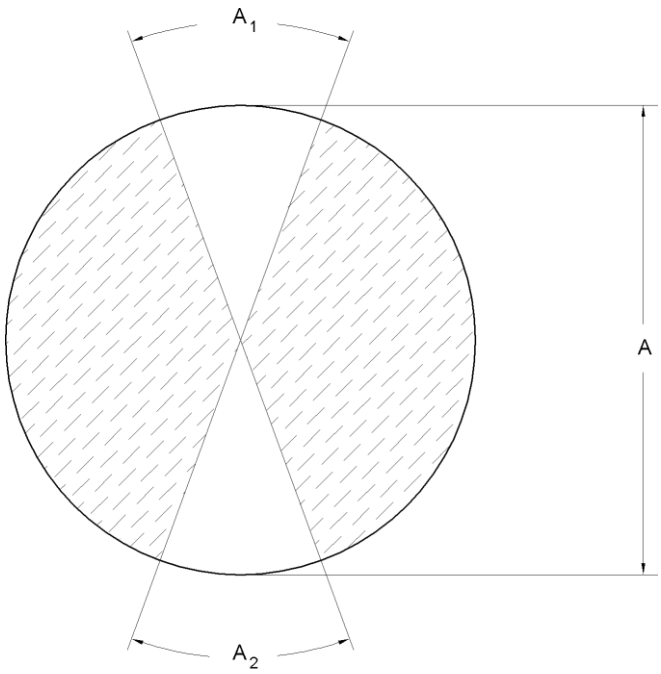



Figure 8002 - Measuring Bearing Liner Diameters

NOTE: During overhaul/service inspection, diameter of bearing liner is considered to be acceptable if not more than 25% of circumference is above the maximum diameter limit (See Figure 8002). When the starter-generator is to be repaired and returned to service on a “continued time” basis, the maximum diameter limit of bearing liner diameter “A” is acceptable if up to 25% of the circumference is not more than 0.0001 inch (0,0025 mm) above maximum diameter limit.

NOTE: Acceptance criteria for used liners, not new or repaired liners.

# SPECIAL TOOLS, FIXTURES AND EQUIPMENT

## 1. Introduction

Table 9001 lists the approved special tools, fixtures, and equipment necessary for starter-generator service.

| Nomenclature | Figure |
|---|---|
| Adapter, Armature Shaft (Anti-Drive End) | Figure 9001 |
| Adapter, Armature Shaft (Drive End) | Figure 9002 |
| Adapter, Commutation Viewing | Figure 9003 |
| Driver, Bearing (Inner Race) | Figure 9004 |
| Driver, Bearing (Outer Race) | Figure 9005 |
| Driver, Dampener Hub | Figure 9006 |
| Driver, Dampener Plate | Figure 9007 |
| Fixture, Commutator Turning | Figure 9008 |
| Fixture, Rivet Alignment and Press | Figure 9009 |
| Plug, Speed Pickup Adjustment<br>(for use on starter-generators without bearing pre-load feature) | Figure 9010 |
| Plug, Speed Pickup Adjustment<br>(for use on starter-generators with bearing pre-load feature) | Figure 9011 |
| Support, Armature | Figure 9012 |
| Support, Bearing and Brush Support Assembly | Figure 9013 |
| Support, Anti-Drive End Hub | Figure 9014 |
| Supports, Drive End Bearing Hub (inboard and outboard) | Figure 9015 |
| Support, Horizontal Stator | Figure 9016 |
| Support, Vertical Stator | Figure 9017 |
| Support, Vertical Shaft | Figure 9018 |
| Wrench, Spline | Figure 9019 |
| PlusNut® Fastener Header | Figure 9020 |
| Dampener Plate Gauge Tool, P/N 19-601076 | Figure 9021 |

Table 9001 - Special Tools, Fixtures and Equipment

## 2. Tool Descriptions and Fabrication Instructions

The drawings in this section provide material and fabrication instructions for the tools listed in Table 9001. Where dimensions and fabrication instructions are provided, the tool or fixture is approved for local manufacture. Unless otherwise specified all measurements are in inches followed by metric equivalents. The tools and fixtures cannot be procured from Safran Power. Equivalent tooling and fixture requirements meeting with Safran Power specifications can be used.

**A. Armature Shaft Adapters. See Figure 9001 and Figure 9002.**

Tolerances on decimals 0.XX ± 0.01 inch (0,25 mm), 0.XXX ± 0.005 inch (0,127 mm). Machined ends to be parallel to within 0.001 inch (0,025 mm) and square with sidewalls within ± 0.05 degree. Materials: Brass, CD-260.

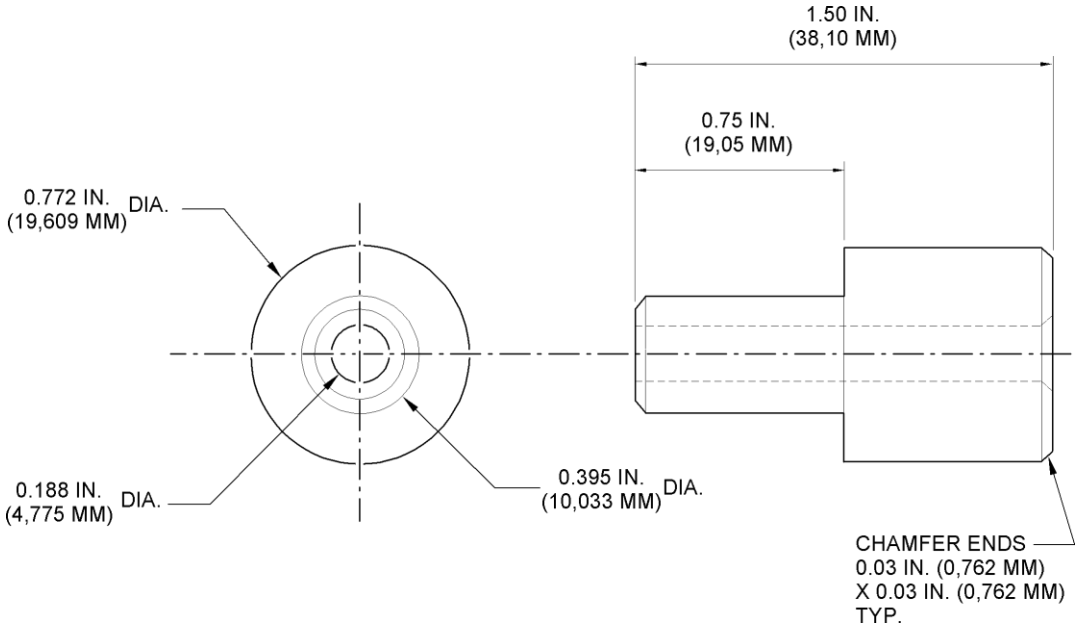



Figure 9001 - Anti-Drive End Armature Shaft Adapter

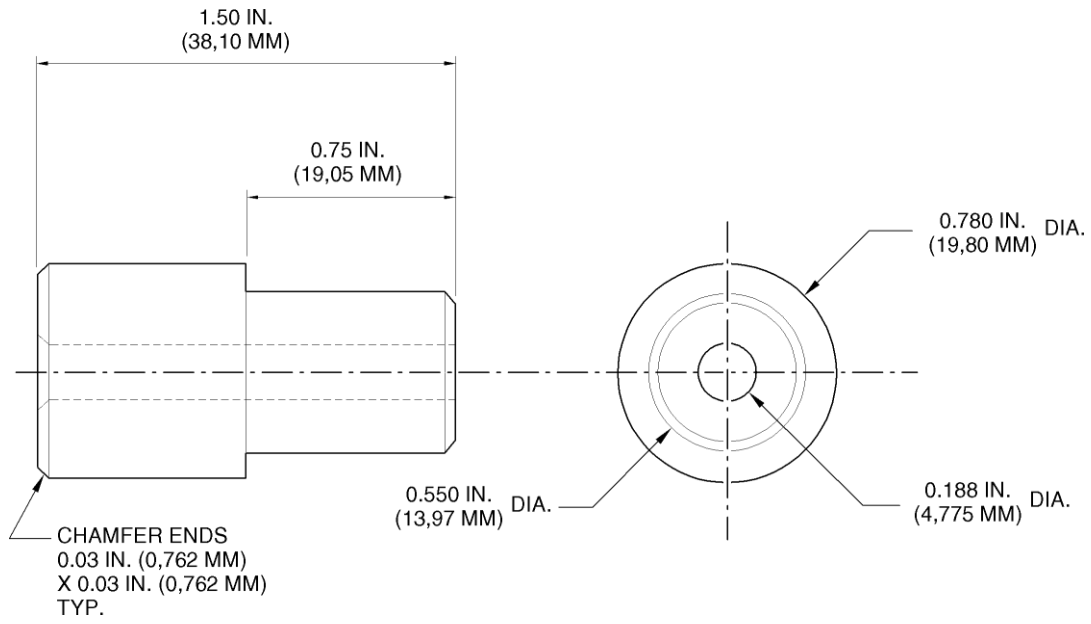



Figure 9002 - Drive End Armature Shaft Adapter

**B. Commutation Viewing Adapters. See Figure 9003.**

This adapter is constructed using a used brush access cover. Two designs are shown. Design one uses four pieces of acrylic, 2.00 inch (50,8 mm) high by 1.75 inch (44,5 mm) wide by 0.063 inch (1,60 mm) thick. Design two uses one piece of acrylic, 19.00 inch (482,6 mm) long by 2.60 inch (66,0 mm) by 0.125 inch (3,18 mm) thick. Construction of these designs is as follows:

(1) Design One

(a) Cut four holes in a brush access cover. Each hole should be positioned above one of the four brush holder assemblies to allow for viewing the brushes as they make contact with the commutator during test.

(b) Cut four pieces of clear acrylic to be larger than the brush access holes in the stator and housing assembly.

(c) Apply adhesive on the inside surface of the viewing adapter to the frame of the cut out viewing windows.

(d) Attach the four pieces of acrylic to the viewing windows on the inner surface of the viewing adapter using four pop rivets.

(2) Design Two

(a) Remove the brackets from a used brush access cover.

(b) Attach the brackets to a piece of clear acrylic.

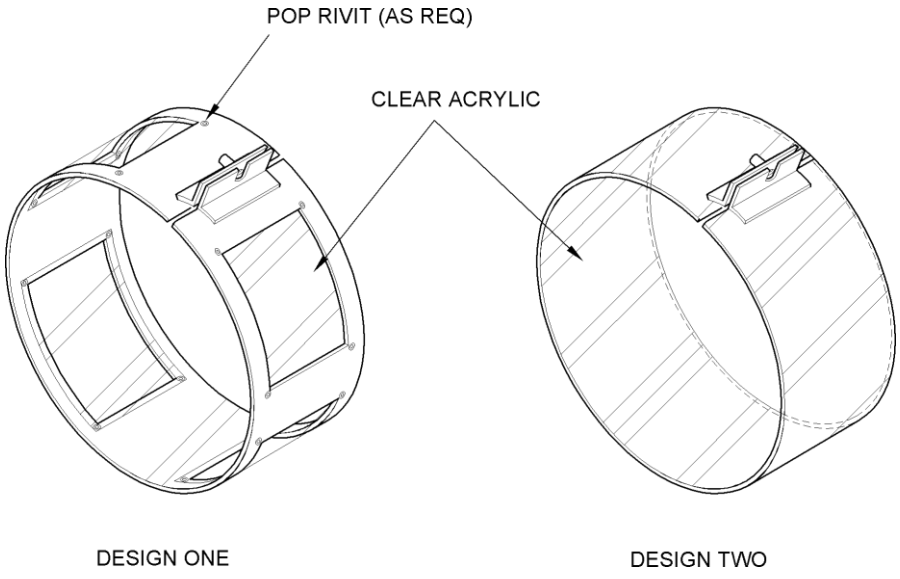



Figure 9003 - Commutation Viewing Adapter

**C. Bearing Drivers. See Figure 9004 and Figure 9005.**

Tolerances on decimals 0.XX ± 0.01 inch (0,25 mm), 0.XXX ± 0.005 inch (0,127 mm). Machined ends to be parallel to within 0.001 inch (0,025 mm) and square with sidewalls within ±0.05 degree. Harden steel to Rockwell Rc 55-60. Material: 1040 Steel, 2.00 inch (50,8 mm) diameter stock size.

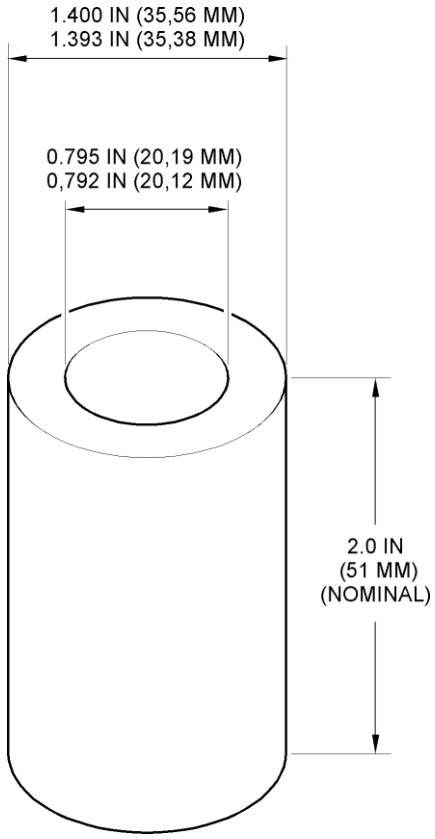



Figure 9004 - Inner Race Bearing Driver

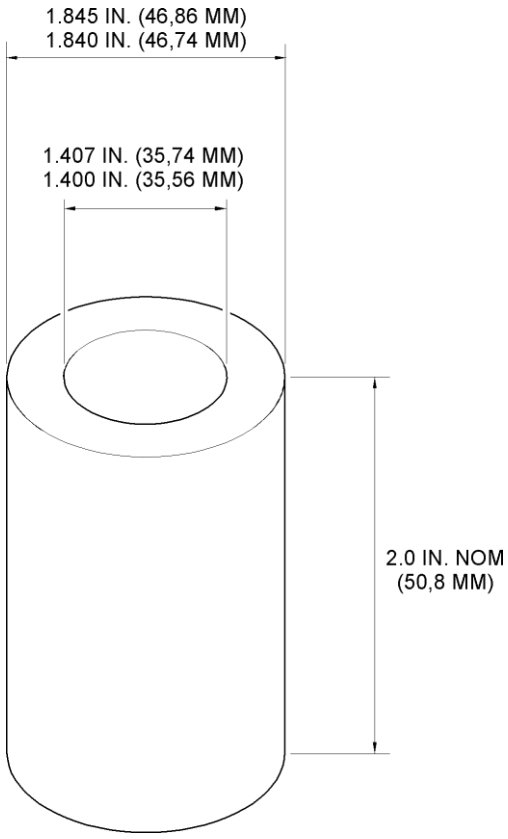



Figure 9005 - Outer Race Bearing Driver

**D. Dampener Hub Driver. See Figure 9006.**

Tolerances on decimals 0.XX ± 0.01 inch (0,25 mm), 0.XXX ± 0.005 inch (0,127 mm). Machined ends to be parallel to within 0.001 inch (0,025 mm) and square with sidewalls within ±0.05 degree. Material: 1040 Steel.

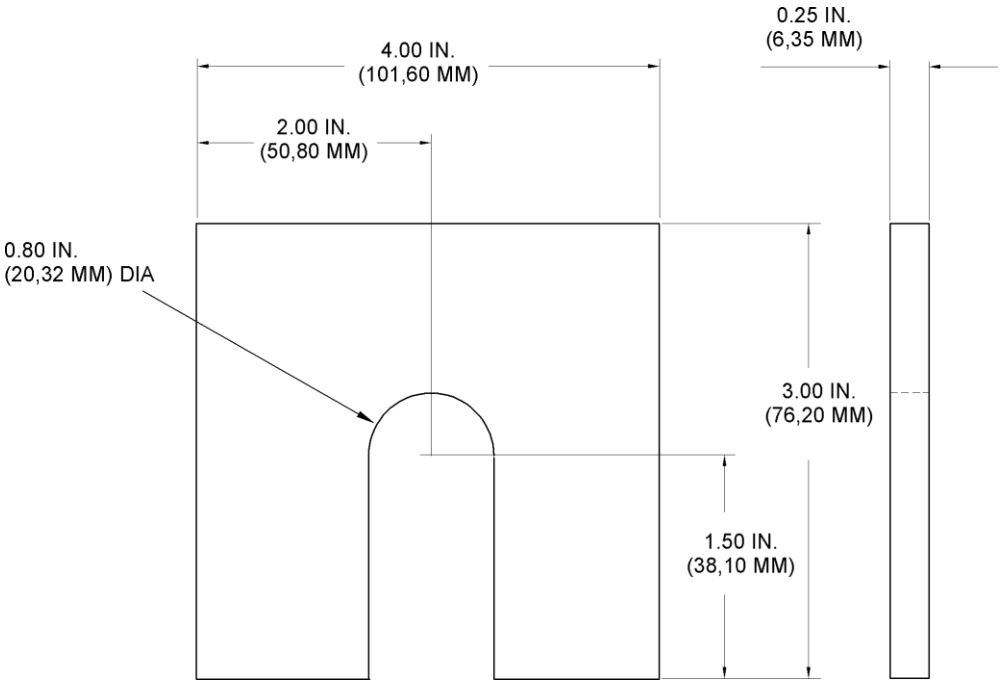



Figure 9006 - Dampener Hub Driver

**E. Dampener Plate Driver. See Figure 9007.**

Harden to Rockwell Rc 55-60.

| | |
|---|---|
| Material: | 01 tool steel or equivalent |
| Stock Size: | 3.0 inch diameter (76,2 mm) |
| Tolerances on: | Decimals 0.XX ± 0.01 inch (0,25 mm)<br>0.XXX ± 0.005 inch (0,127 mm) |
| Angles: | ± 1 Degrees |

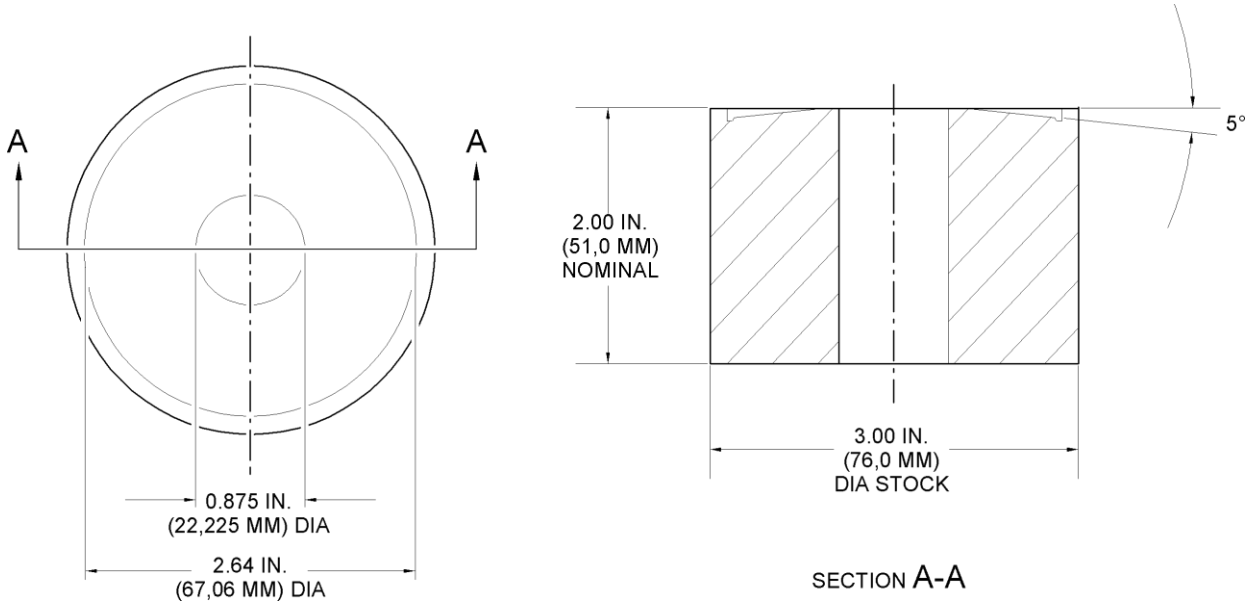



Figure 9007 - Dampener Plate Driver

**F. Commutator Turning Fixture. See** Figure 9008**.**

Tolerances on decimals 0.XX ± 0.01 inch (0,25 mm), 0.XXX ± 0.005 inch (0,127 mm). Machined ends to be parallel to within 0.001 inch (0,025 mm) and square with sidewalls within ±0.05 degree. Harden steel to Rockwell Rc 35-40. Material: 1040 Steel, Stock size: 2.50 inch (63,5 mm) diameter.

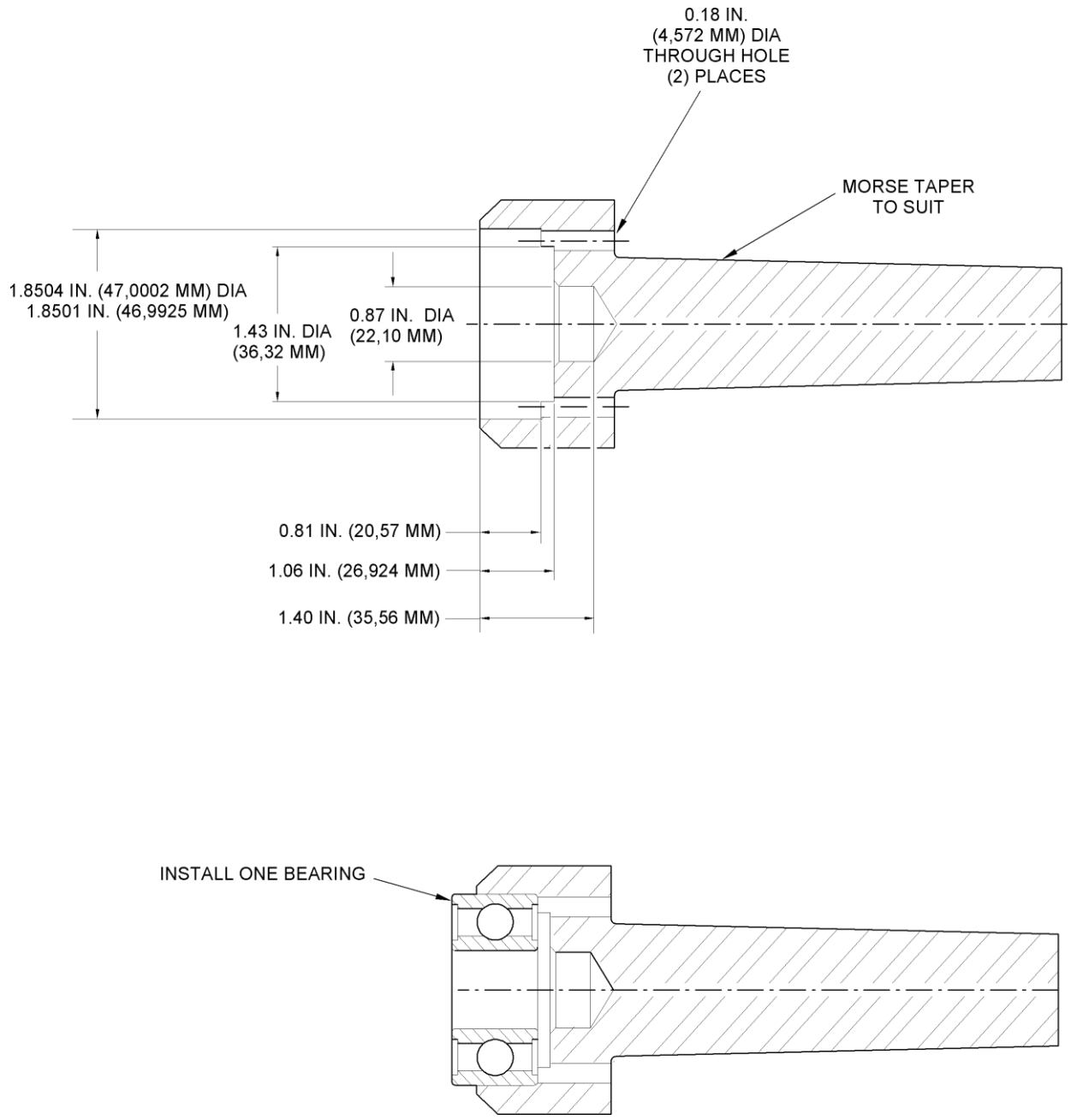


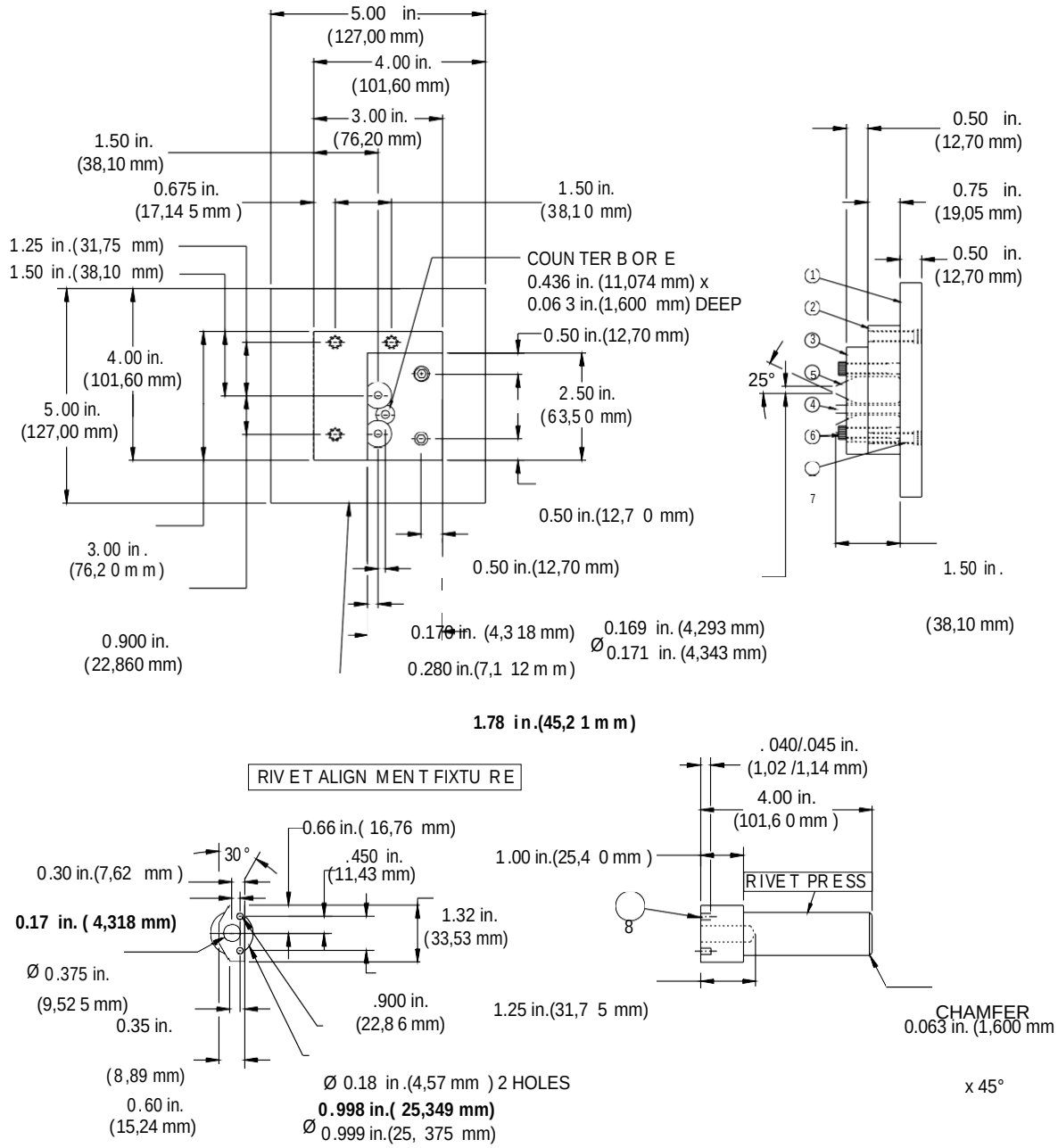

Figure 9008 - Commutator Turning Fixture

## G. Rivet alignment and Press Fixture. See Chart below and Figure 9009

Tolerances on: Decimals 0.XX ± 0.01 inch (± 0,3 mm)
0.XXX ± 0.005 inch (± 0,13 mm)

Angles ± 5 Degrees

**Materials:**




| ITE M | QTY . | DIMEN SIONS | DE SC RIP TION |
|---|---|---|---|
| 8 | 1 | 1 1/2 DIA. (38,10 mm) DIA X 4 1/8 in (10 4,78 mm ) LON G | A2 TOOL STEEL, HAR DE N Rc 5 5-6 0 |
| 7 | 3 | .250 in (6, 35 mm)- 20 | SCRE W, CAP SO CK ET HEA D, COU N TER S UNK |
| 6 | 2 | .190 in (4, 83 mm)- 24 | SCRE W, CAP SO C KET HE AD |

| | | | |
|---|---|---|---|
| 5 | 2 | 5/8 in (15,86 mm) DIA. X 1 3/4 in (44,45 mm) LONG | 01 TOOL STEEL, DRILL ROD |
| 4 | 1 | 3/16 in (4,76 mm) DIA. X 1 3/4 in (44,45 mm) LONG | 01 TOOL STEEL, DRILL ROD |
| 3 | 1 | 1/2 in (12,70 mm) X 2 1/2 in (63,50 mm) X 2 1/2 in (63,50 mm) | 1010 COLD ROLL STEEL |
| 2 | 1 | 3/4 in (19,05 mm) X 3 in (76,20 mm) X 3 in (76,20 mm) | 1010 COLD ROLL STEEL |
| 1 | 1 | 1/2 in (12,70 mm) X 5 in (127,00 mm) X 5 in (127,00 mm) | 1010 COLD ROLL STEEL |

Figure 9009 - Rivet Alignment and Press Fixture

**H. Speed Pickup Adjustment Plug. See Figure 9010 and Figure 9011.**

Tolerances on decimals 0.XX ± 0.01 inch (0,25 mm), 0.XXX ± 0.005 inch (0,127 mm). Ground diameters must be concentric to within 0.0005 inch (0,0127 mm) TIR. Material: 1040 Steel hardened Rc 35-40, Stock size - 2.00 inch (50,8 mm) diameter.

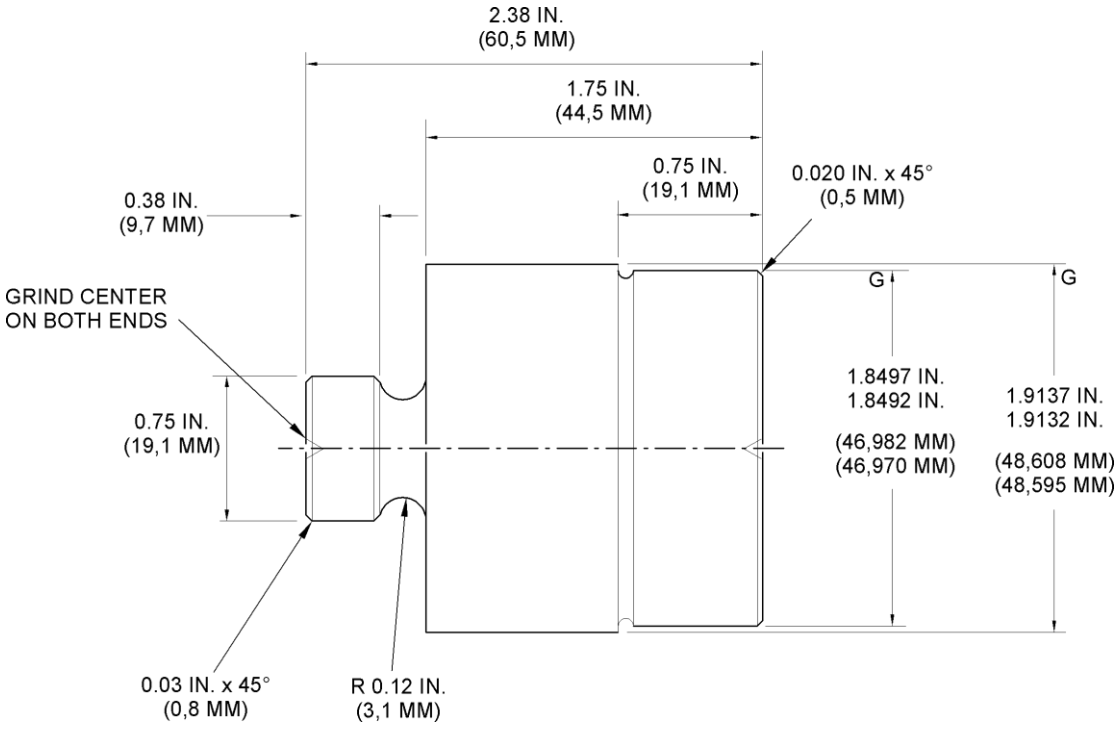



Figure 9010 - Speed Pickup Adjustment Plug (for use with spur gear P/N 23072-1221)

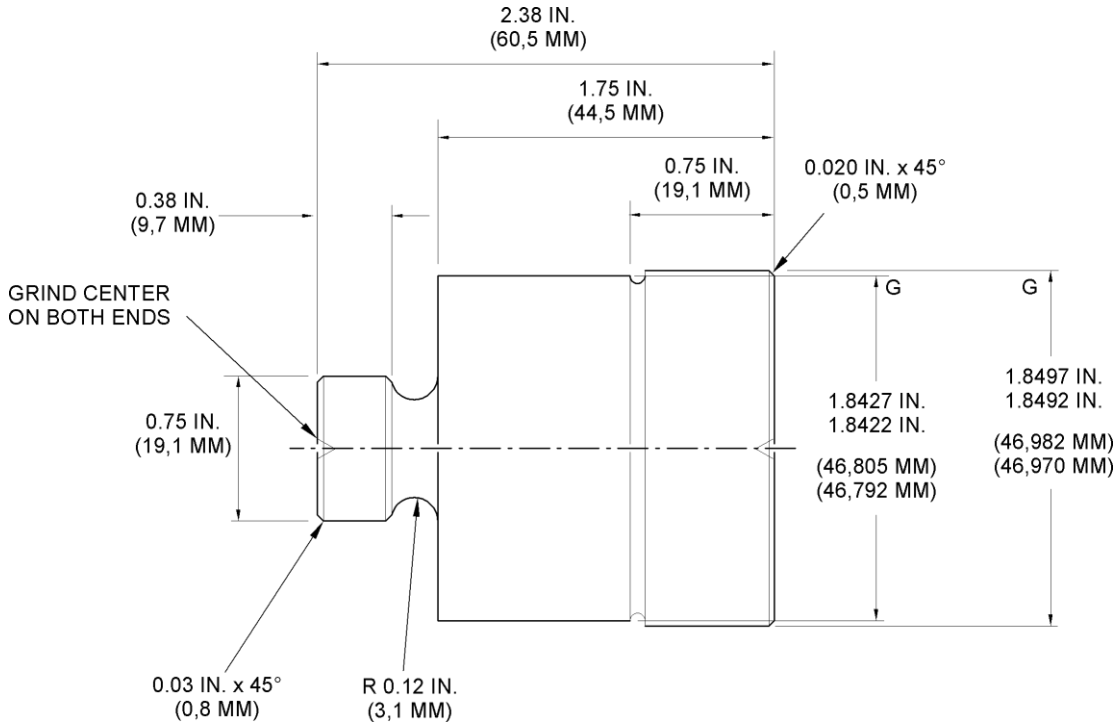



Figure 9011 - Speed Pickup Adjustment Plug (for use with spur gear P/N 23072-1220)

**I. Armature Support. See Figure 9012.**

Material 0-1 tool steel, Rc 35-40. Tolerances on decimal 0.XX ± 0.01 inch (0,25 mm) 0.XXX ± 0.005 inch (0,127 mm).

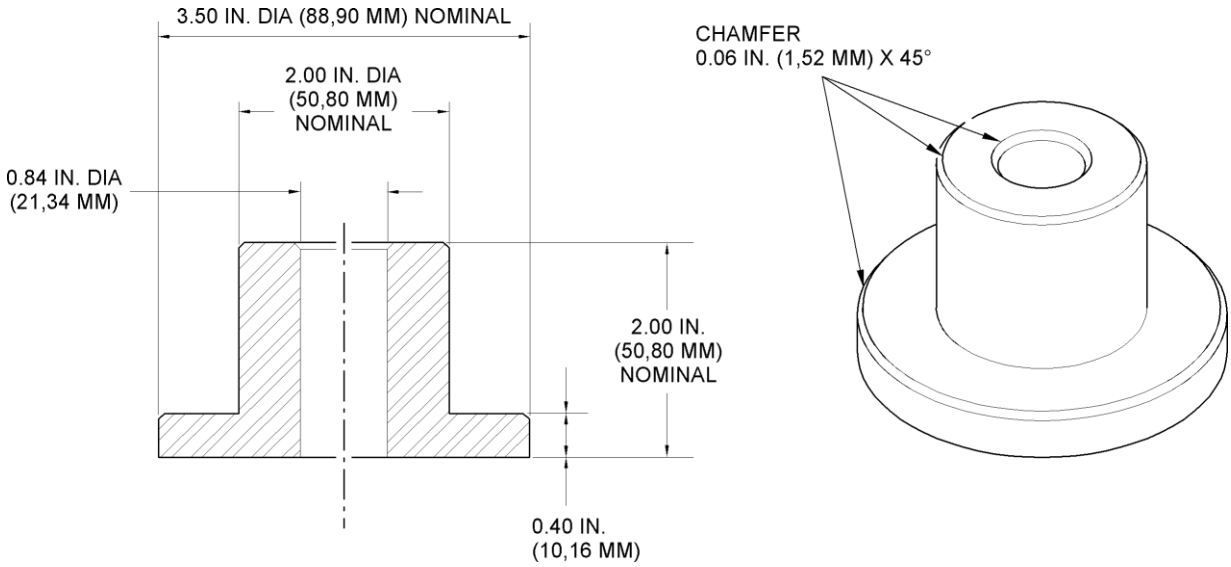



Figure 9012 - Armature Support

**J. Bearing and Brush Support Assembly Support. See Figure 9013.**

Tolerances on decimals 0.XX ± 0.01 inch (0,25 mm), 0.XXX ± 0.005 inch (0,127 mm). Machined ends to be parallel to within 0.001 inch (0,025 mm) and square with sidewalls within ±0.05 degree. Angles ±2°0'. Material is 1040 Steel, Stock size: 6.00 inch (152,4 mm) diameter.

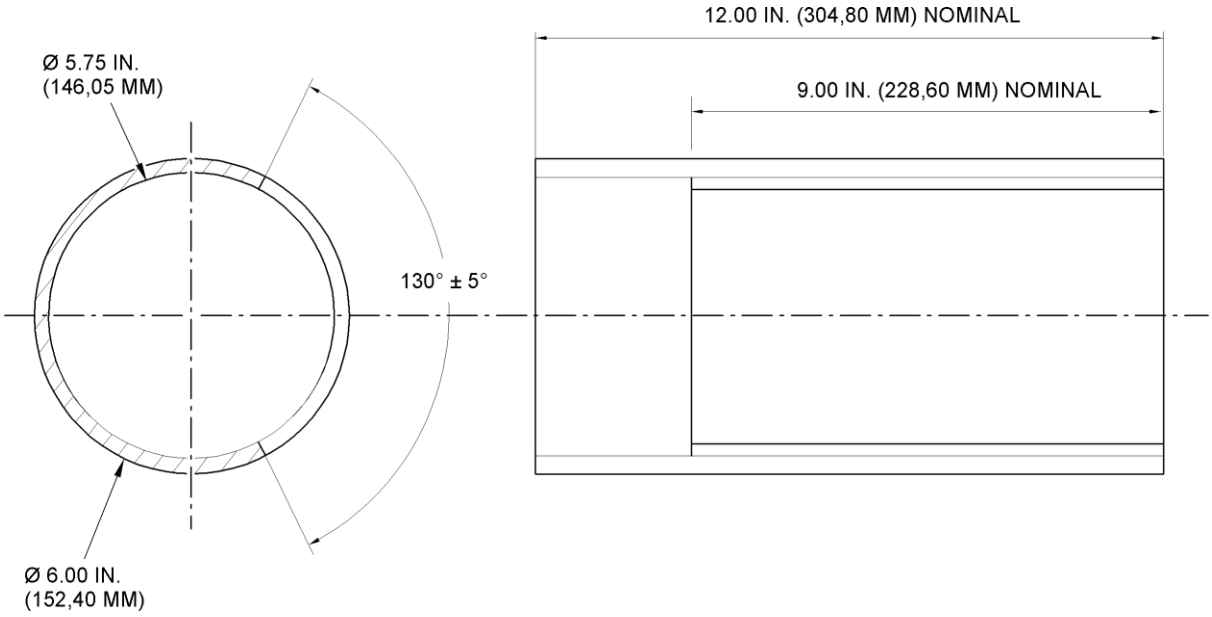



Figure 9013 - Bearing and Brush Support Assembly Support

**K. Anti-Drive End Bearing Hub Support. See Figure 9014.**

Tolerances on decimals 0.XX ± 0.01 inch (0,25 mm), 0.XXX ± 0.005 inch (0,127 mm). Machined ends to be parallel to within 0.001 inch (0,025 mm) and square with sidewalls within ±0.05 degree. Material is 1040 Steel hardened to Rc 35 - 40, Stock size: 2.50 inch (63,5 mm) diameter.

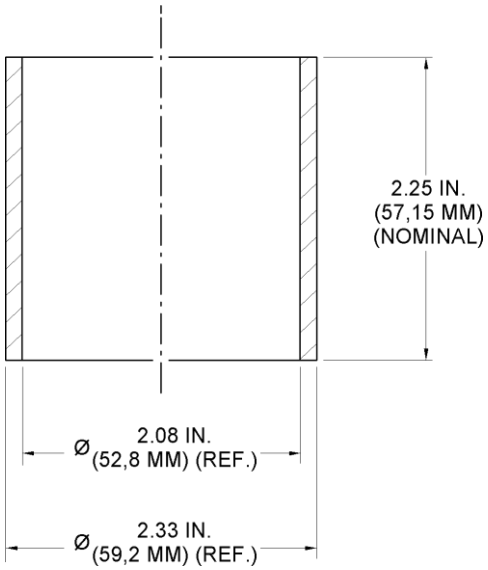



Figure 9014 - Anti-Drive End Bearing Hub Support

**L. Drive End Bearing Hub Supports (Inboard and Outboard). See Figure 9015.**

Tolerances on decimals 0.XX ± 0.01 inch (0,25 mm), 0.XXX ± 0.005 inch (0,127 mm). Machined ends to be parallel to within 0.001 inch (0,025 mm) and square with sidewalls within ±0.05 degree. Angles ±2°0'. Material is 1040 Tool Steel hardened to Rc 35 - 40, Stock size: 2.50 inch (63,5 mm) diameter.

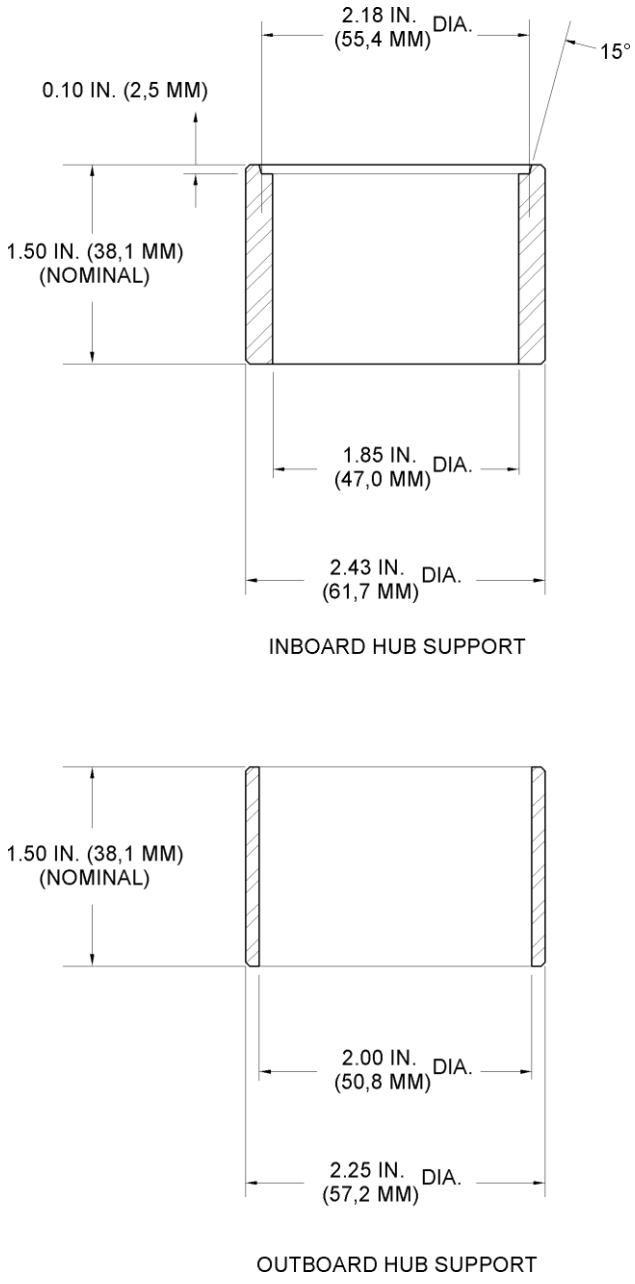



Figure 9015 - Drive End Bearing Hub Supports (Inboard and Outboard)

**M. Horizontal Stator Support. See Figure 9016.**

All dimensions are nominal. The material is a suitable hardwood.

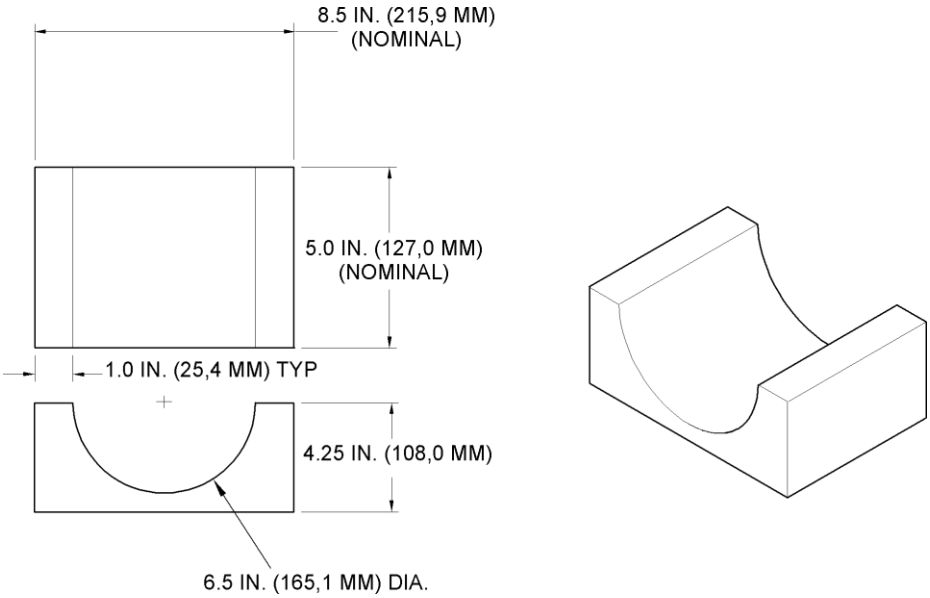



Figure 9016 - Horizontal Stator Support

**N. Vertical Stator Support. See** Figure 9017**.**

All dimensions are nominal. The material is a suitable hardwood.

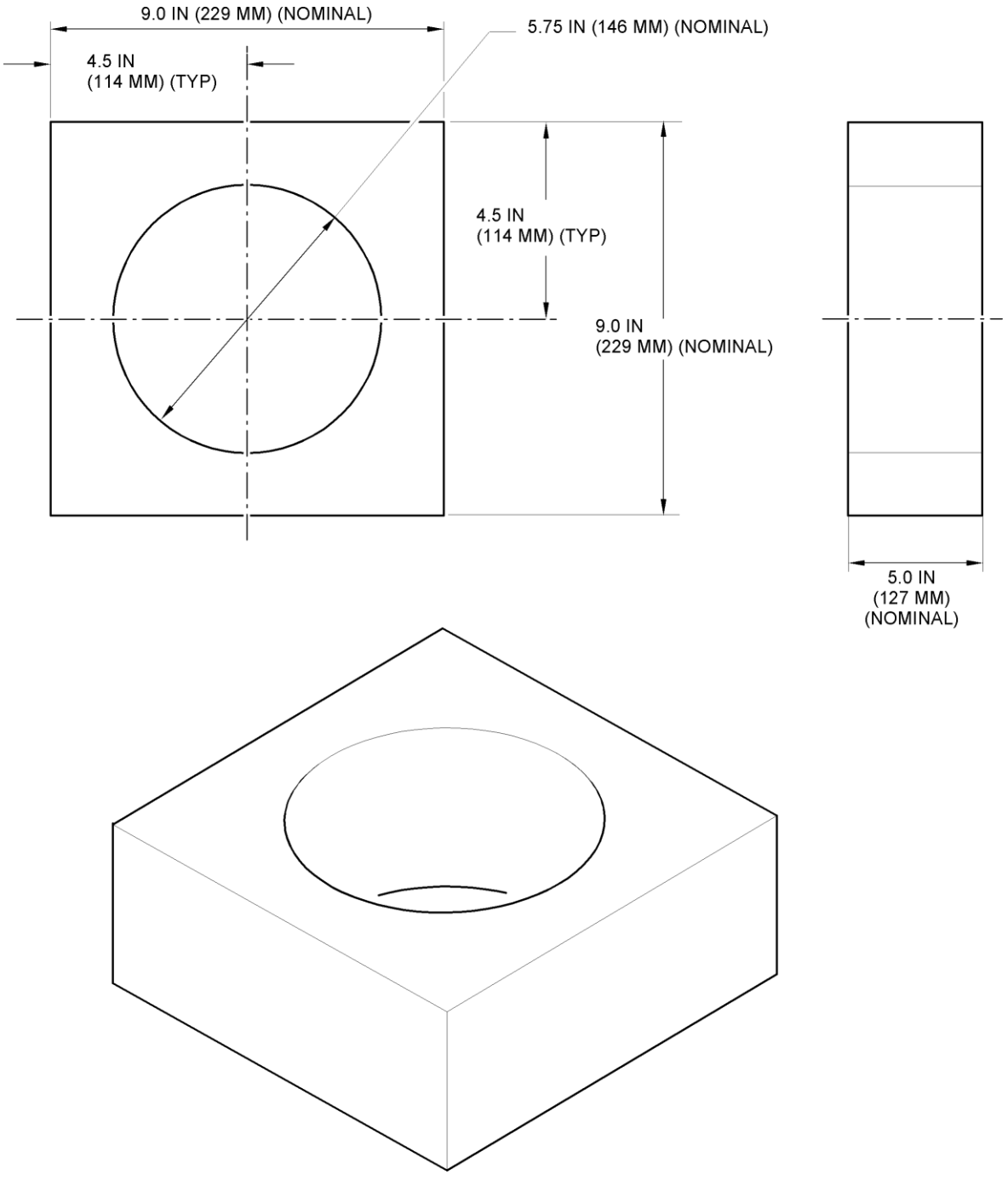



Figure 9017 - Vertical Stator Support

**O. Vertical shaft support. See Figure 9018.**

Tolerances on decimals 0.XX ± 0.01 inch (0,25 mm), 0.XXX ± 0.005 inch (0,127 mm).
Material: AISI-01 tool steel or equivalent, Stock size: 7.00 inch (177,8 mm) diameter.

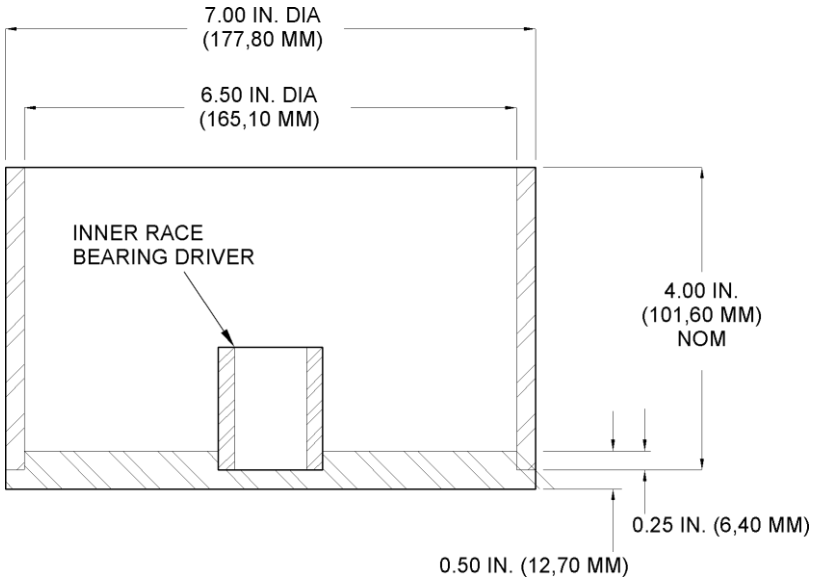
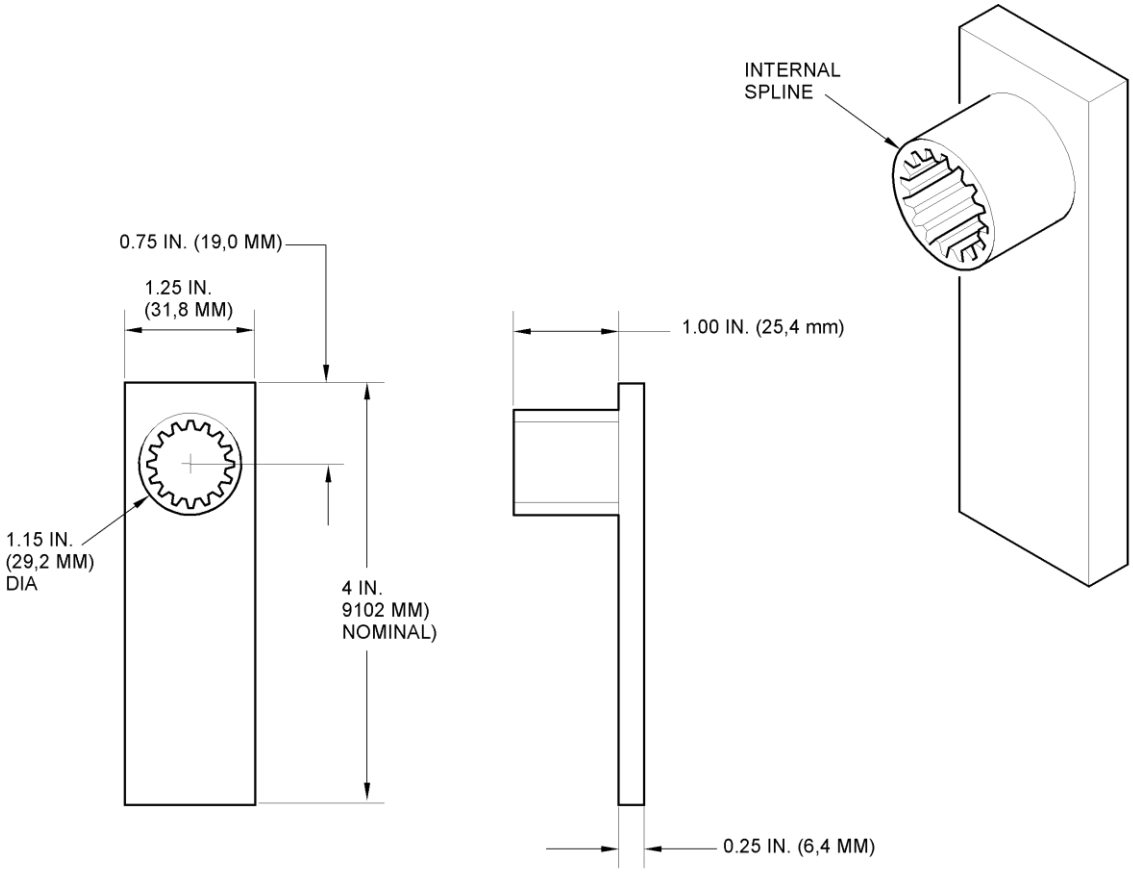



Figure 9018 - Vertical Shaft Support

**P. Spline Wrench. See Figure 9019.**

Tolerances on decimals 0.XX ± 0.01 inch (0,25 mm), 0.XXX ± 0.005 inch (0,127 mm). Machined ends to be parallel to within 0.001 inch (0,025 mm) and square with sidewalls within ±0.05 degree. Angles ±2°0'. Material is 1040 Steel, Stock size: 1.0 inch (25,4 mm) diameter, 4.00 inch (102,0 mm) long x 1.25 inch (31,75 mm) wide.




12 TOOTH SPLINE

| INTERNAL INVOLUTE SPLINE DATA FILLET ROOT SIDE FIT | INCH | MM |
|---|---|---|
| NUMBER OF TEETH | 12 | |
| DIAMETRAL PITCH | 20/40 | |
| PRESSURE ANGLE | 30° | |
| PITCH DIAMETER | 0.6000 | 15,240 |
| MINOR DIAMETER (MIN) | 0.5550 | 14,097 |
| MAJOR DIAMETER (MIN) | 0.6500 | 16,510 |
| CHORD SPACE (MIN) | 0.0730 | 1,853 |
| PIN DIAMETER | 0.0720 | 1,829 |
| BETWEEN THREE 0.0720 IN (1,829 MM) PINS (MIN) | 0.5095 | 12,941 |

16 TOOTH SPLINE

| INTERNAL INVOLUTE SPLINE DATA FILLET ROOT SIDE FIT | INCH | MM |
|---|---|---|
| NUMBER OF TEETH | 16 | |
| DIAMETRAL PITCH | 20/40 | |
| PRESSURE ANGLE | 30° | |
| PITCH DIAMETER | 0.8000 | 20,320 |
| MINOR DIAMETER (MIN) | 0.7270 | 18,590 |
| MAJOR DIAMETER (MIN) | 0.8640 | 21,946 |
| CHORD SPACE (MIN) | 0.0728 | 1,849 |
| PIN DIAMETER | 0.0720 | 1,829 |
| BETWEEN THREE 0.0720 IN (1,829 MM) PINS (MIN) | 0.7096 | 18,024 |

Figure 9019 - Spline Wrench

**Q. PlusNut(R) Fastener Header. See Figure 9020.**

NOTE: For rivet nut replacement - Reference REPAIR section.

Part Number: C1000-1032

Vendor Cage Code: V 0ZVN9

Reference ILLUSTRATED PARTS LIST section for Vendor CAGE Code name and address for tool procurement.

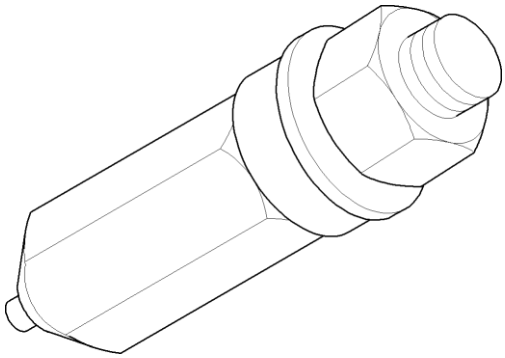
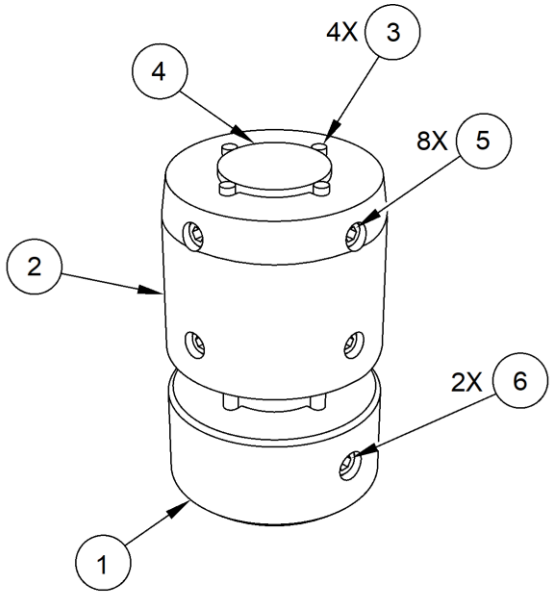


Figure 9020 - PlusNut(R) Fastener Header

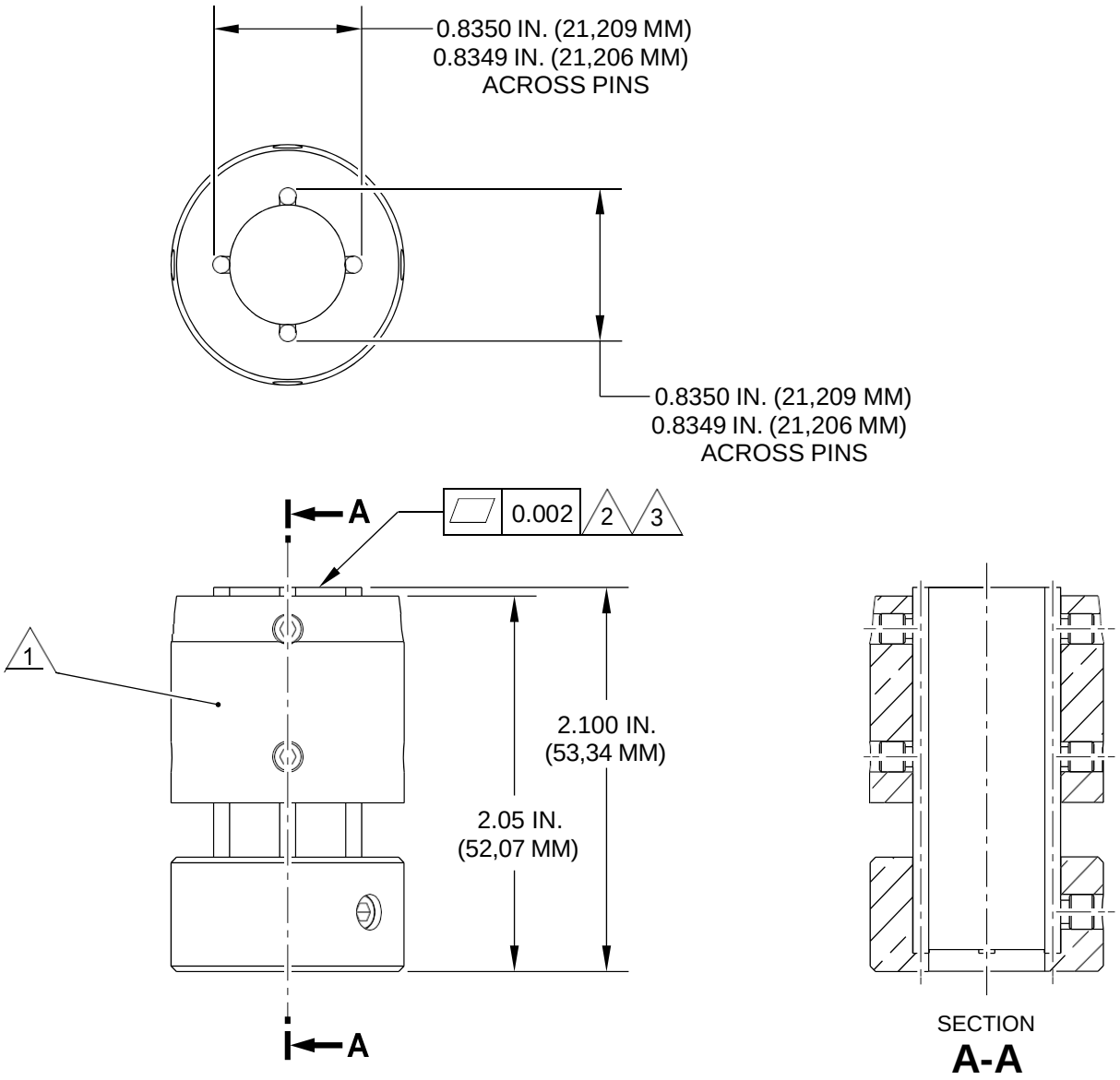
**R. Dampener Plate Gauge Tool. See** Figure 9021**.**

NOTE: To check the splines of the dampener plate - Reference CHECK section.




| ITEM | PART | MATERIAL | QTY. |
|---|---|---|---|
| 1 | BOTTOM COLLAR, KNURLED | W1 TOOL STEEL OR O1 TOOL STEEL | 1 |
| 2 | TOP COLLAR | W1 TOOL STEEL OR O1 TOOL STEEL | 1 |
| 3 | CLASS X GAUGE PIN, Ø 0.0900 IN. (2,286 MM) X 2.00 IN. (50,8 MM) LENGTH | TOOL STEEL | 4 |
| 4 | CLASS X GAUGE PIN, Ø 0.6550 IN. (16,637 MM) X 2.00 IN. (50,8 MM) LENGTH | TOOL STEEL | 1 |
| 5 | #8-32 UNC-3A X 3/16 SET SCREW | STEEL | 8 |
| 6 | #10-24 UNC-3A X 3/16 SET SCREW | STEEL | 2 |

Figure 9021 - Dampener Plate Gauge (P/N 19-601076) (Sheet 1 of 4)




NOTES:

1. MARK TOOL WITH PART NUMBER 19-601076 APPROXIMATELY WHERE SHOWN.
2. WHEN ASSEMBLED, FACES OF ITEMS ④ AND ITEM ③ SHALL MEET REQUIREMENT.
3. DIAMOND KNURL FINISH ITEM ① ON SURFACE INDICATED.

Figure 9021 - Dampener Plate Gauge (P/N 19-601076) (Sheet 2 of 4)

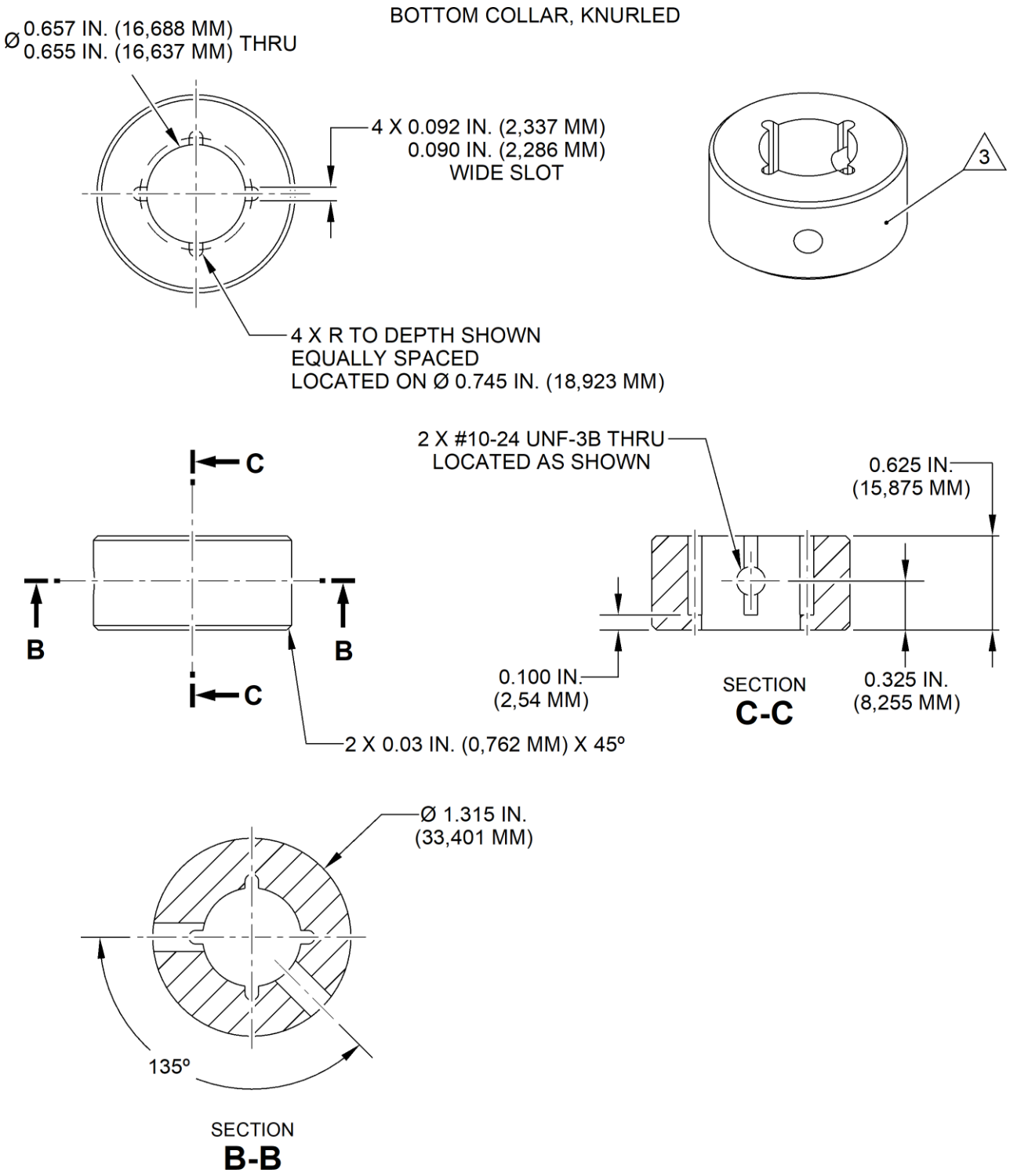



Figure 9021 - Dampener Plate Gauge (P/N 19-601076) (Sheet 3 of 4)

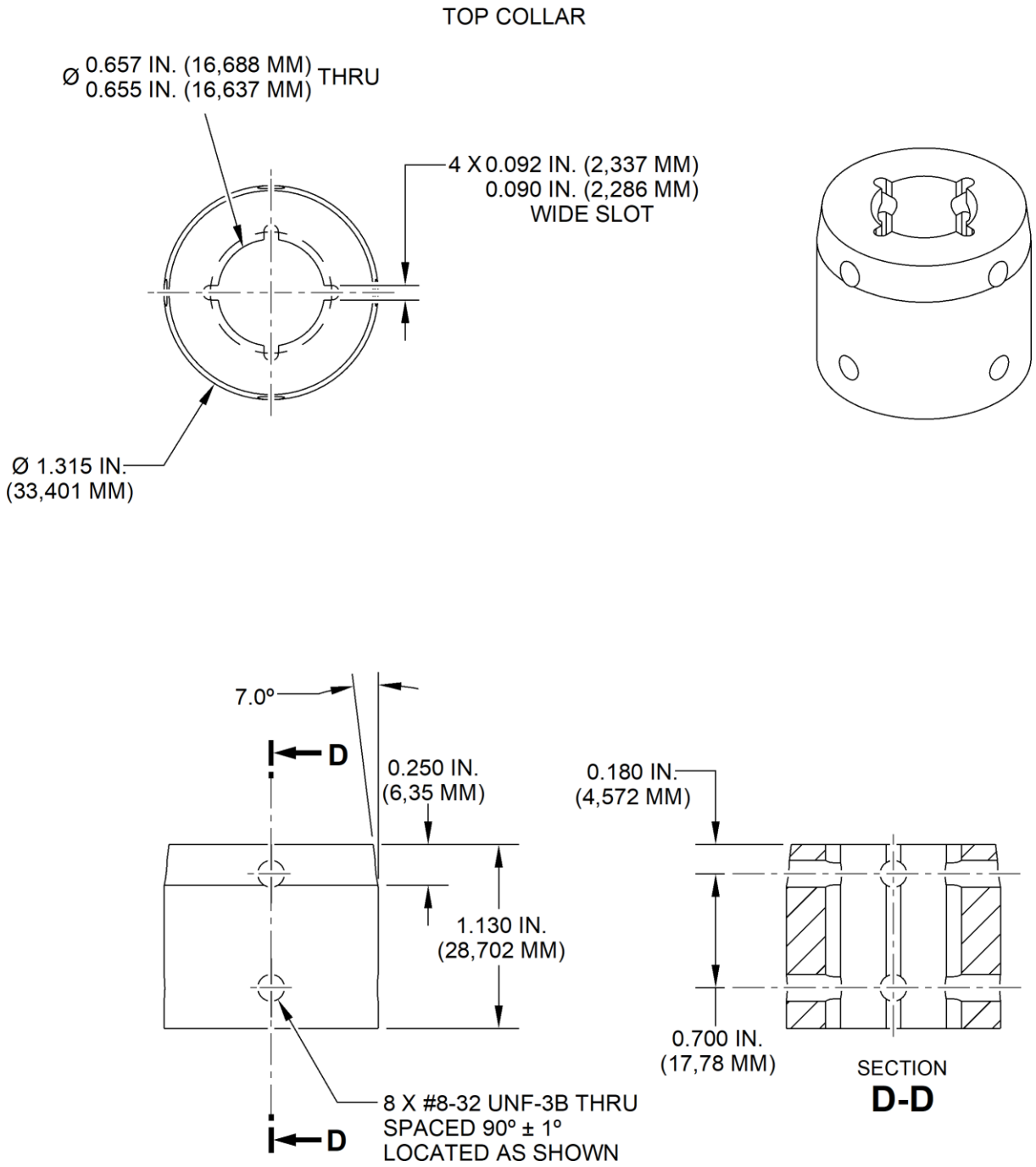



Figure 9021 - Dampener Plate Gauge (P/N 19-601076) (Sheet 4 of 4)

# SPECIAL PROCEDURES

## 1. Introduction

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# REMOVAL

## 1. Introduction

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# INSTALLATION

## 1. Introduction

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# SERVICING

## 1. Introduction

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# STORAGE

## 1. Storage

Materials required to pack the generator for storage or shipment are listed in Table 15001.

| Description | Specification | Quantity |
|---|---|---|
| Bag, waterproof, vapor-proof | Commercially available.<br><br>Bag must totally enclose instructions for installation and then be sealed. | 1 |
| Bag, waterproof, vapor-proof | Kraft-foil or suitable equivalent.<br><br>Bag must totally enclose generator and then be sealed. | 1 |
| Box - domestic class, single wall, corrugated cardboard. | PPP-B-636 or suitable equivalent.<br><br>Box must be large enough to totally enclose and restrain bagged and cushioned generator. | 1 |
| Box - WC5 overseas shipping container. | PPP-B-636 or suitable equivalent.<br><br>Box must be large enough to completely enclose domestic class packaging. | 1 |
| Cardboard Tubing | Commercially available. | AR |
| Chemically Neutral Protective Paper | Commercially available. | AR |
| Desiccant | MIL-D-3464 Type I and II | 1 |
| Grease | MIL-PRF-81322. | AR |
| Packing Material - shock absorbing foam rubber, styrofoam, bubble wrap, or expanded foam.<br>(Safran Power's recommended method: 3 inch (76,2 mm) thick minimum expanded foam surrounding machine on all sides.) | Commercially available. | AR |
| Polyethylene (Plastic) Wrap | Commercially available. | AR |
| Tag | Commercially available. | 1 (Domestic)<br>2 (Internat'l) |
| Tape - waterproof, pressure sensitive. | Commercially available. | AR |

Table 15001 - Packaging Material

## A. General information.

**CAUTION:** IF MACHINE STORAGE TIME IS MORE THAN 24 MONTHS WITH NO USE, IT IS RECOMMENDED THAT ITS BEARINGS BE REPLACED. IT MUST THEN BE RE-TESTED ACCORDING TO TESTING AND FAULT ISOLATION SECTION BEFORE BEING PLACED INTO SERVICE.

(1) Unit must have successfully completed tests specified in TESTING AND FAULT ISOLATION section of this manual before preparing unit for shipment or storage.

(2) Verify that lockwire seal is in place.

(3) Record following information to tag(s):

- Model Number
- Serial Number
- Mod Status
- Test Date (PASSED)
- Packing date

(4) Use packaging materials as specified in Table 15001.

## B. Documentation.

Include all applicable documentation with unit:

- Testing Records
- Repair Reports
- Final Inspection/Check Records
- Packing List and Certificate of Conformance

## C. Domestic Packaging.

(1) For model 23080-056, place O-ring (10001-250) into a small plastic bag and attach to machine.

(2) Apply lubricating grease to drive spline according to MIL-PRF-81322 and wrap it in protective paper according to MIL-B-121A, Grade A, Type II.

(3) Place unit and desiccant into a waterproof and vapor-proof heat-seal bag and partially heat-seal it while forcing as much air as possible from bag.

(4) Insert vacuum tube into bag to draw remaining air out of bag.

(5) Withdraw vacuum tube quickly and complete heat-sealing of bag.

(6) Using machine's original shipping container if possible, place bagged machine into box surrounded with a minimum of 3 inch (76,2 mm) thick shock absorbing, cushioning material on all six sides.

(7) Securely and completely seal all flapped openings of box with tape.

(8) Tape tag to exterior surface of box. Make sure all information is visible.

**D. Overseas Shipment On Surface Vessels.**

(1) Accomplish domestic packaging of machine in accordance with Paragraph 1.C..

(2) Place domestically packaged starter-generator into WC5 shipping container.

(3) Securely and completely, seal all flapped openings of shipping container with tape.

(4) Tape tag to exterior surface of shipping container. Make sure all information is visible.

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# REWORK

## 1. Introduction

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# ILLUSTRATED PARTS LIST

## 1. Introduction

This section contains a listing of assemblies and detail parts for 23291 Series DC Starter-Generators. All parts are listed, but for parts which lose their identities by being permanently fastened to other parts or are part of an assembly not subject to disassembly. Each list is arranged in disassembly sequence, but that attaching parts are listed immediately after the parts they attach, under the heading of ATTACHING PARTS.

All replacement parts are manufactured or source-controlled by Safran Power with the exception of those listed in Paragraph 2.B.

**WARNING: ANY USE OF PARTS, MATERIALS OR PROCEDURES NOT AUTHORIZED BY SAFRAN POWER FOR MAINTENANCE OR OVERHAUL OF UNIT(S) CAN AFFECT CONTINUED AIRWORTHINESS OR INVALIDATE CERTIFICATION.**

To order authorized Safran Power parts, contact your regional Safran Power Customer Service Center.

## 2. Arrangement of Parts List

### A. Figure and Item Number

The figure number indicates the figure where the part is illustrated. Each item number corresponds to a part illustrated in the applicable figure. Several item numbers can have a letter following a number (e.g. 10 A). This indicates that the part has the same function and location as the base number (e.g. 10), but can be different in form and material. An item number that is preceded by a dash (e.g. -30) is not illustrated in the applicable figure.

### B. Part Number

The part numbers listed in this column are the only authorized parts for replacement and overhaul of the starter-generator. Part numbers in this IPL consists mainly of Safran Power part numbers, and does include Military Standard (MS), Army Navy (AN), National Aerospace Standard (NAS) and industry standard (ANSI, ASME, ISO, etc.) part numbers unless a Commercial and Government Entity (CAGE) code appears in the Nomenclature column. Refer to Paragraph 3. for details.

### C. Nomenclature

The proper name and type of each part is provided in this column. The description of each item is indented by columns to indicate the relationship to the next higher assembly. The number of indentures and bullets depicts the relationship of the item to the associated next higher assembly as follows:

(1) The description of each item is indented by columns to indicate the relationship to the next higher assembly (NHA). Each listed item is placed in the NOMENCLATURE column one indenture (one dot) to the right of the assembly to which it belongs. Items at equal indentures are all components of a single assembly or subassembly. The number of indentures and bullets depicts the relationship of the item to the associated next higher assembly as follows:

**1 2 3 4 5**
Assembly, level 1, no bullets
Detail Parts for Assembly, level 2, 1 bullet
Sub-Assembly, level 3, 2 bullets
Attaching Parts for Sub-Assembly, level 4, 3 bullets
Detail Parts for Sub-Assembly, level 5, 4 bullets

The interchangeability relationship between parts is identified in the NOMENCLATURE column of the parts list. A list of the terms used to show interchangeability and their definition is as follows:

| Term | Parts List Abbreviation | Definition |
|---|---|---|
| Alternate | ALT | One of the two part numbers can be used. If the part number in the Nomenclature Column is NOT specified as 'ALT', it can not be used as an alternate. The information is for reference only or as a way to help identify the part. |
| Modification | MOD | Modification (Mod) status details information about effectivity of parts in regard to upgrades and modifications. Alpha variants, A through Y, (I, O, Q, S, X, and Z are not used) are assigned to existing model numbers when necessary. |
| Order separately | | Part is not furnished as part of the starter-generator. |
| Superseded | SUPSD BY | Part number listed is obsolete and must be replaced by the new part listed at the next repair. A superseded part is not to be installed or reinstalled. |
| Supersedes | SUPSDS | Part number listed must replace the obsolete part number at the next repair. |
| Replaced by | REPLD BY | Part number listed is discontinued and should be replaced by the new part number. Original part can be used until current stock is depleted and then must be replaced by the new part listed. |
| Replaces | REPLS | Part listed replaces and is interchangeable with the item number shown in the notation. |

## D. Effect Code

This column establishes part relationships with starter-generator models, which are essentially the same, but have minor variations. These starter-generator models are the end items on the detailed parts list and are assigned reference letters such as A, B, C, D, etc. Subassemblies or detail parts, which are not common to all configurations, but are associated with one or more of the coded end items, carry the letter or letters assigned to the end item(s) with which they are associated. When parts are used on all models, the column is left blank. Effectivity codes are redefined for each major subassembly figure.

### E. Units Per Assembly

The numbers listed in this column indicate the quantity of parts used per assembly at the location shown and are not necessarily the total quantity per unit. For bulk items, the abbreviation AR is used to indicate the part quantity is “as required”. The abbreviation NP indicates non-procurable and refers to items which are not procurable and can not be ordered. The abbreviation RF indicates that the item is listed for reference only.

## 3. Vendors

In the case of an item supplied by a vendor and not listed under the prime manufacturer's part number, a vendor CAGE code is prefixed by the capital letter V appearing in the nomenclature column. This CAGE code number designates the original manufacturer of non-Safran Power components, and is in accordance with Cataloging Hand Books H4-1, H4-2, and H4-3. CAGE codes are listed in Table 10001, except for the government codes below, which are not listed:

| | |
|---|---|
| V80205 | National Aircraft Standard (prefix NAS) |
| V81349 | Military Specifications (prefix M) |
| V88044 | Army/Navy Standard (prefix AN) |
| V96906 | Military Standard (prefix MS) |

The Customer Support division in your region is to be contacted for parts dispatch.

The following is an index of the manufacturers names addresses and codes as used in the listing.

| VENDOR CODE | NAME AND ADDRESS |
|---|---|
| V05972 | Loctite Corp.<br>705 N. Mountain Rd.<br>Newington, CT 06111 |
| V0LAX1 | National Paper and Packaging Co.<br>1240 E. 55th Street<br>Cleveland, OH 44103 |
| V0SR97 | Chase Corporation<br>Humi-Seal Division<br>26-60 Brooklyn-Queens Expressway<br>P.O. Box 446<br>Woodside, NY 11377 |
| V0ZVN9 | Omni Fastener, Inc.<br>9000 Sweet Valley Dr.<br>Valley View, Oh 44125 |
| V38360 | Markem Corporation<br>150 Congress Street<br>Keene, NH 03431-4307 |

Table 10001 - CAGE Codes

| VENDOR CODE | NAME AND ADDRESS |
|---|---|
| V6W965 | United Packaging Co.<br>16800 S. Waterloo Rd.<br>Cleveland, OH 44110-3807 |
| V71643 | CHR Industries<br>407 East Street<br>New Haven, CT 06509 |
| V72688 | John C. Dolph Co.<br>West New Rd.<br>P.O. Box 267<br>Monmouth Junction, NJ 08852-9513 |
| V94058 | Brulin Corporation<br>P. O. Box 270<br>Indianapolis IN 46206 |
| V97785 | Federal Process Co.<br>3737 Park East Drive<br>Beechwood, OH 44122-4307 |

Table 10001 - CAGE Codes

## 4. NOTES

NOTE 1: The 23080 Series DC starter-generators included in this CMM are not supplied with a QAD kit. QAD kit must be ordered separately.

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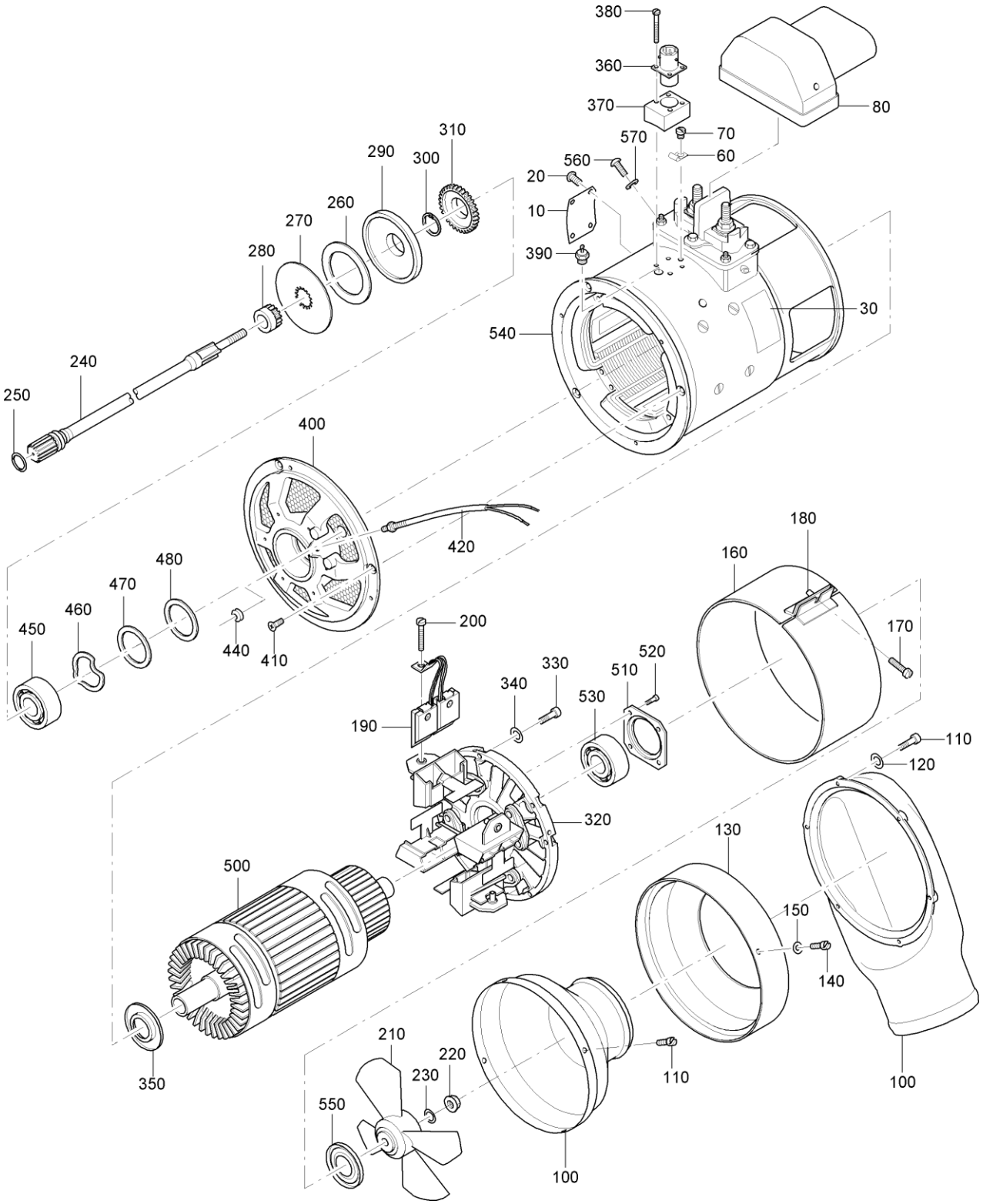


Figure 10001 - DC Starter-Generator

| FIGURE AND ITEM | PART NUMBER | NOMENCLATURE 1 2 3 4 5 | EFFECT CODE | QTY PER ASSY |
|---|---|---|---|---|
| 10001- | | | | |
| | 23291-005 | DC STARTER-GENERATOR . . . . . (See Note 1) See Figure 10005 for details of QAD. | A | RF |
| | 23291-006 | DC STARTER-GENERATOR . . . . . (See Note 1) See Figure 10005 for details of QAD. | B | RF |
| | 23291-007 | DC STARTER-GENERATOR . . . . . (See Note 1) See Figure 10005 for details of QAD. | C | RF |
| 10 | 06-209284 | • PLATE, Identification, Replacement . . . | A,B,C | 1 |
| | 06-209285 | • PLATE, Identification, Replacement . . . | A,B,C | 1 |
| | 06-209287 | • PLATE, Identification, Replacement . . . | A,B,C | 1 |
| | | (ATTACHING PARTS) | | |
| 20 | MS21318-14 | • SCREW, Drive. . . . . REPLD BY MS21318-13 | A,B,C | 4 |

- ITEM NOT ILLUSTRATED

| FIGURE AND ITEM | PART NUMBER | NOMENCLATURE 1 2 3 4 5 | EFFECT CODE | QTY PER ASSY |
|---|---|---|---|---|
| 10001- | | | | |
| 20 (Cont'd) | MS21318-13 | • SCREW, Drive.....MOD H<br>REPLS MS21318-14,<br>Refer to SB 23291-XXX-24-07 | A | 4 |
| | MS21318-13 | • SCREW, Drive.....MOD G<br>REPLS MS21318-14,<br>Refer to SB 23291-XXX-24-07 | B | 4 |
| | MS21318-13 | • SCREW, Drive.....MOD C<br>REPLS MS21318-14,<br>Refer to SB 23291-XXX-24-07 | C | 4 |
| | MS21318-13 | • SCREW, Drive. . . . . | A,B,C | 4 |
| | | ---------- * ---------- | A,B,C | |
| 30 | 06-201020 | • DECAL, CAUTION . . . . . | A,B,C | 1 |
| -40 | 06-200001 | • LABEL, Patent Notification . . . . . | A,B,C | 1 |
| -50 | 06-201145 | • LABEL, TSO . . . . . | A,B,C | 1 |
| | 06-201139 | • LABEL, TSO . . . . . | A,B,C | 1 |
| 60 | 05-417454 | • CLAMP, Speed Sensor . . . . . | A,B,C | 1 |
| | | (ATTACHING PARTS) | A,B,C | |
| 70 | MS35266-59 | • SCREW, Fillister Head . . . . . | A,B,C | 1 |
| | MS35266-59 | • SCREW, Fillister Head . . . . . <br>ALT: MS35266-60 | A,B,C | 1 |
| | | ---------- * ---------- | A,B,C | |
| 80 | 23076-1200-1 | • COVER, Terminal Block . . . . . | A,B,C | 1 |
| | 23079-1060 | • COVER, Terminal Block . . . . . | A,B,C | 1 |
| | | (ATTACHING PARTS) | A,B,C | |
| -90 | NAS1189-06P12L | • SCREW. . . . . | A,B,C | 2 |
| | | ---------- * ---------- | A,B,C | |
| 100 | 23080-1050 | • INLET, Air . . . . . | A,B,C | 1 |
| | 23080-1050 | • INLET, Air (Ordered Separately) . . . . . | A,B,C | RF |
| | 23080-1140 | • INLET, Air . . . . . <br>REPLD BY 23080-1141 | A,B,C | 1 |
| | 23080-1141 | • INLET, Air . . . . . <br>REPLS 23080-1140 | A,B,C | 1 |

- ITEM NOT ILLUSTRATED

| FIGURE AND ITEM | PART NUMBER | NOMENCLATURE 1 2 3 4 5 | EFFECT CODE | QTY PER ASSY |
|---|---|---|---|---|
| 10001- | | | | |
| 100 (Cont'd) | 23080-1580 | • COVER, Fan . . . . . REPLD BY 23080-1142 | A,B,C | 1 |
| | 23080-1142 | • INLET, Air . . . . . REPLS 23080-1580 | A,B,C | 1 |
| | 23065-1342 | • INLET, Air . . . . . REPLD BY 23065-1344 | A,B,C | 1 |
| | 23065-1344 | • INLET, Air . . . . . REPLS 23065-1342, REPLD BY 23065-1341 | A,B,C | 1 |
| | 23065-1341 | • INLET, Air . . . . . | A,B,C | 1 |
| | 23065-1341 | • INLET, Air . . . . . REPLS 23065-1344 | A,B,C | 1 |
| | 23080-1581 | • INLET, Air (Ordered Separately) . . . . . | A,B,C | RF |
| | | (ATTACHING PARTS) | A,B,C | |
| 110 | MS35265-43 | • SCREW, Fillister Head . . . . . | A,B,C | 4 |
| | MS35265-65 | • SCREW, Fillister Head . . . . . REPLD BY MS35265-47 | A,B,C | 5 |
| | MS35265-47 | • SCREW, Fillister Head . . . . . REPLS MS35265-65 | A,B,C | 5 |
| 120 | AN960-8 | • WASHER, Flat . . . . . | A,B,C | 5 |
| | | ---------- * ---------- | A,B,C | |
| 130 | 23080-1130 | • FAN SHROUD. . . . . | A,B,C | 1 |
| | 23080-1131 | • FAN SHROUD. . . . . | A,B,C | 1 |
| | | (ATTACHING PARTS) | A,B,C | |
| 140 | MS35265-43 | • SCREW, Fillister Head . . . . . | A,B,C | 4 |
| 150 | 05-370232 | • WASHER, Flat . . . . . | A,B,C | 4 |
| | | ---------- * ---------- | A,B,C | |
| 160 | 23075-1022 | • COVER, Brush Access . . . . . REPLD BY 23075-1021 | A,B,C | 1 |
| | 23075-1021 | • COVER, Brush Access . . . . . | A,B,C | 1 |
| | 23075-1021 | • COVER, Brush Access . . . . . REPLS 23075-1022 | A,B,C | 1 |
| | | (ATTACHING PARTS) | | |
| 170 | AN502-10-14 | • • SCREW, Machined, Fillister Head. . . | | 1 |

- ITEM NOT ILLUSTRATED

| FIGURE AND ITEM | PART NUMBER | NOMENCLATURE 1 2 3 4 5 | EFFECT CODE | QTY PER ASSY |
|---|---|---|---|---|
| 10001- | | | | |
| 180 | NAS1329H3K130L | • • NUT, Blind Rivet, Self-locking . . . . . ALT: 01-200376 | A,B,C | 1 |
| | | ---------- * ---------- | A,B,C | |
| 190 | 30300-1296 | • BRUSH, Electrical. . . . . SUPSD BY 30300-1298 | A,B,C | RF |
| | 30300-1298 | • BRUSH, Electrical. . . . . SUPSDS 30300-1296, SUPSD BY 23080-1903 | A,B,C | RF |
| | 30300-1298 | • BRUSH, Electrical. . . . . SUPSD BY 23080-1903 | A,B,C | RF |
| | 23080-1903 | • BRUSH, Electrical. . . . . | A,B,C | 4 |
| | 23080-1903 | • BRUSH, Electrical.....MOD E SUPSDS 30300-1298 Refer to SB 23291-XXX-24-02 | A,B,C | 4 |
| | 23080-1903 | • BRUSH, Electrical.....MOD D SUPSDS 30300-1298, Refer to SB23291-XXX-24-02 | A,B,C | 4 |
| | 23080-1903 | • BRUSH, Electrical.....MOD C ALT: 30300-1298 | A,B,C | 4 |
| | 23080-1971 | • BRUSH, Electrical. . . . . | A,B,C | 4 |
| | 23080-1983 | • BRUSH, Electrical. . . . . (ATTACHING PARTS) | A,B,C<br>A,B,C | 4 |
| 200 | 05-340209 | • SCREW. . . . . | A,B,C | 4 |
| | | ---------- * ---------- | A,B,C | |
| 210 | 23065-1740 | • FAN, Axial . . . . . | A,B,C | 1 |
| | 23065-1740 | • FAN, Axial . . . . . REPLD BY 23065-1747 | A,B,C | 1 |
| | 23065-1742 | • FAN, Axial . . . . . | A,B,C | 1 |
| | 23065-1747 | • FAN, Axial.....MOD J REPLS 23065-1740, Refer to SB 23291-XXX-24-08 | A,B,C | 1 |
| | 23065-1747 | • FAN, Axial.....MOD C REPLS 23065-1740, Refer to SB 23291-XXX-24-08 | A,B,C | 1 |
| | 23065-1747 | • FAN, Axial.....MOD B REPLS 23065-1740, Refer to SB 23291-XXX-24-08 | A,B,C | 1 |
| | 23065-1747 | • FAN, Axial.....MOD A | A,B,C | 1 |
| | 23065-1747 | • FAN, Axial . . . . . | A,B,C | 1 |

- ITEM NOT ILLUSTRATED

| FIGURE AND ITEM | PART NUMBER | NOMENCLATURE 1 2 3 4 5 | EFFECT CODE | QTY PER ASSY |
|---|---|---|---|---|
| 10001- | | | | |
| | | (ATTACHING PARTS) | | |
| 220 | 02-4107-01 | • NUT, Self-Locking . . . . . REPLD BY MS21042-4 | A,B,C | 1 |
| | MS21042-4 | • NUT, Self-Locking . . . . . | A,B,C | 1 |
| | MS21042-4 | • NUT, Self-Locking . . . . . REPLS 02-4107-01 | A,B,C | 1 |
| 230 | AN960-416L | • WASHER, Flat . . . . . REPLD BY AN960-416 | A,B,C | 1 |
| | AN960-416 | • WASHER, Flat . . . . . | A,B,C | 1 |
| | AN960-416 | • WASHER, Flat . . . . . REPLS AN960-416L | A,B,C | 1 |
| | | * | A,B,C | |
| 240 | 23046-2152 | • SHAFT, Drive, 16 Tooth Spline . . . . . | A,B,C | 1 |
| | 02-6100-16 | • SHAFT, Drive, 12 Tooth Spline . . . . . | A,B,C | 1 |
| 250 | M83248/1-113 | • O-RING . . . . . | A,B,C | 1 |
| 260 | 02-5600-05 | • RING, Friction. **WARNING: CAN . . . . . CONTAIN ASBESTOS** SUPSD BY 02-5600-13 | A,B,C | RF |
| | 02-5600-13 | • RING, Friction . . . . . | A,B,C | 1 |
| | 02-5600-13 | • RING, Friction . . . . . SUPSDS 02-5600-05, Refer to SIL 02-5600 | A,B,C | 1 |
| 270 | 23032-1910 | • PLATE, Dampener . . . . . | A,B,C | 1 |
| 280 | 23032-1900 | • HUB, Dampener . . . . . | A,B,C | 1 |
| 290 | 23032-2710 | • BACK PLATE, Dampener . . . . . | A,B,C | 1 |
| 300 | MS16628-1078 | • RING, Retaining . . . . . | A,B,C | 1 |
| 310 | 23072-1220 | • GEAR, Spur, Speed Pickup. . . . . REPLD BY 23072-1221 | A,B,C | 1 |
| | 23072-1221 | • GEAR, Spur, Speed Pickup. . . . . | A,B,C | 1 |
| | 23072-1221 | • GEAR, Spur, Speed Pickup,.....MOD J REPLS 23072-1220, Refer to SB 23291-XXX-24-07 | A,B,C | 1 |

- ITEM NOT ILLUSTRATED

| FIGURE AND ITEM | PART NUMBER | NOMENCLATURE 1 2 3 4 5 | EFFECT CODE | QTY PER ASSY |
|---|---|---|---|---|
| 10001- | | | | |
| 310 (Cont'd) | 23072-1221 | • GEAR, Spur, Speed Pickup, . . . MOD H<br>REPLS 23072-1220,<br>Refer to SB 23291-XXX-24-07 | A,B,C | 1 |
| | 23072-1221 | • GEAR, Spur, Speed Pickup,.....MOD A<br>REPLS 23072-1220 | A,B,C | 1 |
| 320 | 23075-333 | • SUPPORT ASSEMBLY, Bearing . . . . .<br>and Brush<br>(See Figure 10002 for details)<br>ALT: 23075-332,<br>REPLD BY 23065-367 | A,B,C | RF |
| | 23065-367 | • SUPPORT ASSEMBLY, Bearing. . . . . .<br>and Brush<br>(See Figure 10002 for details)<br>ALT: 23075-333, 23075-332,<br>23065-366,<br>REPLS 23075-333,<br>REPLD BY 23080-360 | A,B,C | RF |
| | 23065-367 | • SUPPORT ASSEMBLY, Bearing. . . . . .<br>and Brush<br>(See Figure 10002 for details)<br>ALT: 23075-333, 23075-332,<br>23065-366,<br>REPLD BY 23080-360 | A,B,C | RF |
| | 23080-360 | • SUPPORT ASSEMBLY, Bearing. . . . . .<br>and Brush<br>(See Figure 10002 for details) | A,B,C | 1 |
| | 23080-360 | • SUPPORT ASSEMBLY, Bearing. . . . . .<br>and Brush MOD H<br>(See Figure 10002 for details)<br>REPLS 23065-367, 23075-333,<br>23075-332, 23065-366,<br>Refer to SB 23291-XXX-24-09 | A | 1 |
| | 23080-360 | • SUPPORT ASSEMBLY, Bearing. . . . . .<br>and Brush MOD G<br>(See Figure 10002 for details)<br>REPLS 23065-367, 23075-333,<br>23075-332, 23065-366,<br>Refer to SB 23291-XXX-24-09 | B | 1 |
| | 23080-360 | • SUPPORT ASSEMBLY, Bearing. . . . . .<br>and Brush MOD C<br>(See Figure 10002 for details)<br>REPLS 23065-367, 23075-333,<br>23075-332, 23065-366,<br>Refer to SB 23291-XXX-24-09 | C | 1 |

- ITEM NOT ILLUSTRATED

| FIGURE AND ITEM | PART NUMBER | NOMENCLATURE 1 2 3 4 5 | EFFECT CODE | QTY PER ASSY |
|---|---|---|---|---|
| 10001- | | | | |
| 320 (Cont'd) | 23080-360 | • SUPPORT ASSEMBLY Bearing . . . . . and Brush MOD F (See Figure 10002 for details) ALT: 23065-367 | A,B,C | 1 |
| | | (ATTACHING PARTS) | A,B,C | |
| 330 | MS21262-28 | • SCREW, Self-Locking . . . . . | A,B,C | 8 |
| 340 | 05-370232 | • WASHER, Flat . . . . . | A,B,C | 8 |
| | | ---------- * ---------- | A,B,C | |
| 350 | G128-178 | • DISC, BAFFLE . . . . . REPLD BY 23080-3110 Refer to SIL 23080-3110-01 | A,B,C | RF |
| | 23080-3110 | • DISC, BAFFLE . . . . . REPLD BY 23032-1145 | A,B,C | RF |
| | 23080-3110 | • DISC, BAFFLE . . . . . REPLS G128-178, REPLD BY 23032-1145 | A,B,C | 1 |
| | 23032-1145 | • SPACER . . . . . REPLD BY 23080-3111 | A,B,C | 1 |
| | 23032-1145 | • SPACER . . . . . | A,B,C | 1 |
| | 23032-1145 | • SPACER . . . . . REPLS 23080-3110, REPLD BY 23080-3111 | A,B,C | 1 |
| | 23032-1145 | • SPACER . . . . . REPLS 23080-3110 | A,B,C | 1 |
| | 23032-1145 | • SPACER.....MOD J REPLS 23080-3110, Refer to SB 23291-XXX-24-07 | A,B,C | 1 |
| | 23032-1145 | • SPACER.....MOD H REPLS 23080-3110, Refer to SB 23291-XXX-24-07 | A,B,C | 1 |
| | 23032-1145 | • SPACER.....MOD H REPLS 23080-3110, Refer to SB 23291-XXX-24-07, REPLD BY 23080-3111 | A,B,C | 1 |
| | 23080-3111 | • SHIELD, Drive End Bearing .....MOD J REPLS 23032-1145, Refer to SB 23291-XXX-24-08 | A,B,C | 1 |
| | 23080-3111 | • SHIELD, Drive End Bearing . . . MOD C REPLS 23032-1145, Refer to SB 23291-XXX-24-08 | A,B,C | 1 |

- ITEM NOT ILLUSTRATED

| FIGURE AND ITEM | PART NUMBER | NOMENCLATURE 1 2 3 4 5 | EFFECT CODE | QTY PER ASSY |
|---|---|---|---|---|
| 10001- | | | | |
| 350 (Cont'd) | 23080-3111 | • SHIELD, Drive End Bearing .....MOD B<br>REPLS 23032-1145,<br>Refer to SB 23291-XXX-24-08 | A,B,C | 1 |
| | 23080-3111 | • SHIELD, Drive End Bearing .....MOD A<br>REPLS 23032-1145,<br>Refer to SB 23291-XXX-24-08 | A,B,C | 1 |
| | 23080-3111 | • SHIELD, Drive End Bearing . . . . . | A,B,C | 1 |
| 360 | MS3112E8-3P | • CONNECTOR, Receptacle . . . . . | A,B,C | 1 |
| | | (ATTACHING PARTS) | A,B,C | |
| 370 | 23076-1240 | • SPACER . . . . . | A,B,C | 1 |
| 380 | MS35265-20 | • SCREW. . . . . | A,B,C | 4 |
| | | ---------- * ---------- | A,B,C | |
| 390 | 23076-1250 | • SWITCH, Thermal. . . . . | A,B,C | 1 |
| 400 | 23072-1085 | • BEARING SUPPORT ASSEMBLY, . . . .<br>Drive End<br>(See Figure 10003 for details)<br>REPLD BY 23080-1348 | A,B,C | 1 |
| | 23080-1348 | • BEARING SUPPORT ASSEMBLY, . . . .<br>Drive End<br>(See Figure 10003 for details)<br>REPLD BY 23080-381 | A,B,C | 1 |
| | 23080-1348 | • BEARING SUPPORT ASSEMBLY, . . . .<br>Drive End MOD G<br>(See Figure 10003 for details)<br>REPLS 23072-1085,<br>REPLD BY 23080-381 | A,B,C | 1 |
| | 23080-1348 | • BEARING SUPPORT ASSEMBLY, . . . .<br>Drive End MOD F<br>(See Figure 10003 for details)<br>REPLS 23072-1085,<br>REPLD BY 23080-381 | A,B,C | 1 |
| | 23080-1348 | • BEARING SUPPORT ASSEMBLY, . . . .<br>Drive End MOD E<br>(See Figure 10003 for details)<br>REPLS 23072-1085,<br>REPLD BY 23080-381 | A,B,C | 1 |

- ITEM NOT ILLUSTRATED

| FIGURE AND ITEM | PART NUMBER | NOMENCLATURE 1 2 3 4 5 | EFFECT CODE | QTY PER ASSY |
|---|---|---|---|---|
| 10001- | | | | |
| 400 (Cont'd) | 23080-381 | • BEARING SUPPORT ASSEMBLY, . . . . Drive End (Pre-Load) MOD A (See Figure 10003 for details) REPLS 23080-1348 | A,B,C | 1 |
| | 23080-381 | • BEARING SUPPORT ASSEMBLY, . . . . Drive End (Pre-Load) MOD J (See Figure 10003 for details) REPLS 23080-1348, Refer to SB 23291-XXX-24-07 | A,B,C | 1 |
| | 23080-381 | • BEARING SUPPORT ASSEMBLY, . . . . Drive End (Pre-Load) MOD H (See Figure 10003 for details) REPLS 23080-1348, Refer to SB 23291-XXX-24-07 | A,B,C | 1 |
| | 23080-381 | • BEARING SUPPORT ASSEMBLY, . . . . Drive End (Pre-Load) MOD G (See Figure 10003 for details) REPLS 23080-1348 ALT: 23080-1348, ALT: 23072-1085 | A,B,C | 1 |
| | 23080-381 | • BEARING SUPPORT ASSEMBLY, . . . . Drive End (Pre-Load) (See Figure 10003 for details) | A,B,C | 1 |
| | 23080-1351 | • BEARING SUPPORT ASSEMBLY, . . . . Drive End (See Figure 10003 for details) REPLD BY 23080-383 | A,B,C | 1 |
| | 23080-383 | • BEARING SUPPORT ASSEMBLY, . . . . Drive End (Pre-Load) MOD A (See Figure 10003 for details) REPLS 23080-1351 | A,B,C | 1 |
| | 23080-386 | • BEARING SUPPORT ASSEMBLY, . . . . Drive End (Pre-Load) (See Figure 10003 for details) | A,B,C | 1 |
| | | (ATTACHING PARTS) | A,B,C | |
| 410 | MS24693-S23 | • SCREW. . . . . | A,B,C | 3 |
| | | ---------- * ---------- | A,B,C | |
| 420 | 23072-1280 | • PICKUP, Speed. . . . . REPLD BY 23072-1400 | A,B,C | 1 |
| | 23072-1400 | • PICKUP, Speed. . . . . | A,B,C | 1 |
| | 23072-1400 | • PICKUP, Speed. . . . . REPLS 23072-1280 | A,B,C | 1 |

- ITEM NOT ILLUSTRATED

| FIGURE AND ITEM | PART NUMBER | NOMENCLATURE 1 2 3 4 5 | EFFECT CODE | QTY PER ASSY |
|---|---|---|---|---|
| 10001- | | | | |
| -430 | 23080-1660 | • SPACER, Shaft . . . . . | A,B,C | 1 |
| 440 | MS35489-1 | • GROMMET . . . . . | A,B,C | 1 |
| 450 | 03-6010-08 | • BEARING, Ball . . . . . SUPSD BY 03-6010-15 | A,B,C | RF |
| | 03-6010-08 | • BEARING, Ball,.....MOD A dated 8/87 and later, SUPSD BY 03-6010-15 | A | RF |
| | 03-6010-15 | • BEARING, Ball.....MOD B SUPSDS 03-6010-08, SUPSD BY 03-6010-18 | A | 1 |
| | 03-6010-15 | • BEARING, Ball.....MOD A SUPSDS 03-6010-08, SUPSD BY 03-6010-18 | B | 1 |
| | 03-6010-12 | • BEARING, Ball . . . . . SUPSD BY 03-6010-10 | C | 1 |
| | 03-6010-10 | • BEARING, Ball . . . . . SUPSDS 03-6010-12, SUPSD BY 03-6010-14 | C | 1 |
| | 03-6010-14 | • BEARING, Ball.....MOD A SUPSDS 03-6010-10, SUPSD BY 03-6010-18 | C | 1 |
| | 03-6010-18 | • BEARING, Ball . . . . . | A,B,C | 1 |
| | 03-6010-18 | • BEARING, Ball.....MOD A | A,B,C | 1 |
| | 03-6010-18 | • BEARING, Ball.....MOD C SUPSDS 03-6010-15, Refer to SB 23291-XXX-24-01 | A,B,C | 1 |
| | 03-6010-18 | • BEARING, Ball.....MOD B SUPSDS 03-6010-15, | A,B,C | 1 |
| | 03-6010-18 | • BEARING, Ball.....MOD B SUPSDS 03-6010-14, Refer to SB 23291-XXX-24-01 | A,B,C | 1 |
| | 03-6010-19 | • BEARING, Ceramic Hybrid Ball. . . . . Refer to SB 23291-059-24-02 and SB 23080-023B-24-02 | A,B,C | 1 |
| | 03-6010-19 | • BEARING, Ceramic Hybrid Ball. . . . . | A,B,C | 1 |
| 460 | 02-4231-02 | • WASHER, Spring Wave . . . . . Refer to SB 23291-XXX-24-07 | A,B,C | 1 |
| 470 | 23080-1940 | • SHIM, 0.003 inch (0,08 mm) Steel . . . . | | AR |
| 480 | 23080-1941 | • SHIM, 0.020 inch (0,51 mm) Steel . . . . | | AR |

- ITEM NOT ILLUSTRATED

| FIGURE AND ITEM | PART NUMBER | NOMENCLATURE 1 2 3 4 5 | EFFECT CODE | QTY PER ASSY |
|---|---|---|---|---|
| 10001- | | | | |
| -490 | 23080-1942 | • SHIM, 0.030 inch (0,76 mm) Steel . . . . Shims added, Refer to SB 23291-XXX-24-07 | | AR |
| 500 | 23072-314 | • ARMATURE . . . . . REPLD BY 23080-370 | A,B,C | RF |
| | 23080-370 | • ARMATURE . . . . . | A,B,C | 1 |
| | 23080-370 | • ARMATURE.....MOD D Refer to SB 23291-XXX-24-04 | A | 1 |
| | 23080-370 | • ARMATURE.....MOD C Refer to SB 23291-XXX-24-04 | B | 1 |
| | 23080-370 | • ARMATURE.....MOD E Refer to SB 23291-XXX-24-04 | C | 1 |
| | 23080-370 | • ARMATURE.....MOD B ALT: 23072-314 | A,B,C | 1 |
| 510 | 23046-1111 | • RETAINER, Bearing . . . . . | A,B,C | 1 |
| | | (ATTACHING PARTS) | A,B,C | |
| 520 | MS24694-S3 | • SCREW, Flat Head . . . . . | A,B,C | 4 |
| | | ---------- * ---------- | A,B,C | |
| 530 | 03-6010-08 | • BEARING, Ball . . . . . SUPSD BY 03-6010-15 | A,B | RF |
| | 03-6010-08 | • BEARING, Ball,.....MOD A dated 8/87 and later, SUPSD BY 03-6010-15 | A | RF |
| | 03-6010-15 | • BEARING, Ball.....MOD B SUPSDS 03-6010-08, SUPSD BY 03-6010-18 | A | 1 |
| | 03-6010-15 | • BEARING, Ball.....MOD A SUPSDS 03-6010-08, SUPSD BY 03-6010-18 | B | 1 |
| | 03-6010-12 | • BEARING, Ball . . . . . SUPSD BY 03-6010-10 | C | 1 |
| | 03-6010-10 | • BEARING, Ball . . . . . SUPSDS 03-6010-12, SUPSD BY 03-6010-14 | C | 1 |
| | 03-6010-14 | • BEARING, Ball.....MOD A SUPSDS 03-6010-10, SUPSD BY 03-6010-18 | C | 1 |
| | 03-6010-18 | • BEARING, Ball . . . . . | A,B,C | 1 |
| | 03-6010-18 | • BEARING, Ball.....MOD A | A,B,C | 1 |

- ITEM NOT ILLUSTRATED

| FIGURE AND ITEM | PART NUMBER | NOMENCLATURE 1 2 3 4 5 | EFFECT CODE | QTY PER ASSY |
|---|---|---|---|---|
| 10001- | | | | |
| 530 (Cont'd) | 03-6010-18 | • BEARING, Ball.....MOD C SUPSDS 03-6010-15, Refer to SB 23291-XXX-24-01 | A | 1 |
| | 03-6010-18 | • BEARING, Ball.....MOD B SUPSDS 03-6010-15, | B | 1 |
| | 03-6010-18 | • BEARING, Ball.....MOD B SUPSDS 03-6010-14, Refer to SB 23291-XXX-24-01 | C | 1 |
| | 03-6010-19 | • BEARING, Ceramic Hybrid Ball. . . . . Refer to SB 23291-059-24-02 and SB 23080-023B-24-02 | A,B,C | 1 |
| | 03-6010-19 | • BEARING, Ceramic Hybrid Ball. . . . . | A,B,C | 1 |
| 540 | 23076-332 | • STATOR AND HOUSING ASSEMBLY . (See Figure 10004 for details) REPLD BY 23076-339 | A,B,C | 1 |
| | 23076-335 | • STATOR AND HOUSING ASSEMBLY . (See Figure 10004 for details) REPLD BY 23076-339 | A,B,C | 1 |
| | 23076-339 | • STATOR AND HOUSING ASSEMBLY . (See Figure 10004 for details) | A,B,C | 1 |
| | 23076-339 | • STATOR AND HOUSING ASSEMBLY . (See Figure 10004 for details) REPLS 23076-332, MOD F Refer to SB 23291-XXX-24-05 | A,B,C | 1 |
| | 23076-339 | • STATOR AND HOUSING ASSEMBLY . (See Figure 10004 for details) REPLS 23076-332, MOD E Refer to SB 23291-XXX-24-05 | A,B,C | 1 |
| | 23076-339 | • STATOR AND HOUSING ASSEMBLY . (See Figure 10004 for details) REPLS 23076-335, MOD G Refer to SB 23291-XXX-24-05 | A,B,C | 1 |
| | 23076-339 | • STATOR AND HOUSING ASSEMBLY . (See Figure 10004 for details) ALT: 23076-332, MOD D Refer to SB 23291-XXX-24-05 | A,B,C | 1 |
| | 23080-324 | • STATOR AND HOUSING ASSEMBLY . (See Figure 10004 for details) | A,B,C | 1 |
| 550 | 23080-3112 | • SHIELD, Bearing, Anti-Drive End . . . . . Refer to SB 23291-XXX-24-08, MOD J | A,B,C | 1 |

- ITEM NOT ILLUSTRATED

| FIGURE AND ITEM | PART NUMBER | NOMENCLATURE 1 2 3 4 5 | EFFECT CODE | QTY PER ASSY |
|---|---|---|---|---|
| 10001- | | | | |
| 550 (Cont'd) | 23080-3112 | • SHIELD, Bearing, Anti-Drive End . . . . . Refer to SB 23291-XXX-24-08, MOD C | A,B,C | 1 |
| | 23080-3112 | • SHIELD, Bearing, Anti-Drive End . . . . . Refer to SB 23291-XXX-24-08, MOD B | A,B,C | 1 |
| | 23080-3112 | • SHIELD, Bearing, Anti-Drive End . . . . . Refer to SB 23291-XXX-24-08, MOD A | A,B,C | 1 |
| | 23080-3112 | • SHIELD, Bearing, Anti-Drive End . . . . . | A,B,C | 1 |
| 560 | MS35266-60 | • SCREW, Fillister Head, Grounding . . . . | A,B,C | 1 |
| 570 | MS35335-32 | • WASHER, Lock, External Tooth . . . . . | A,B,C | 1 |

- ITEM NOT ILLUSTRATED

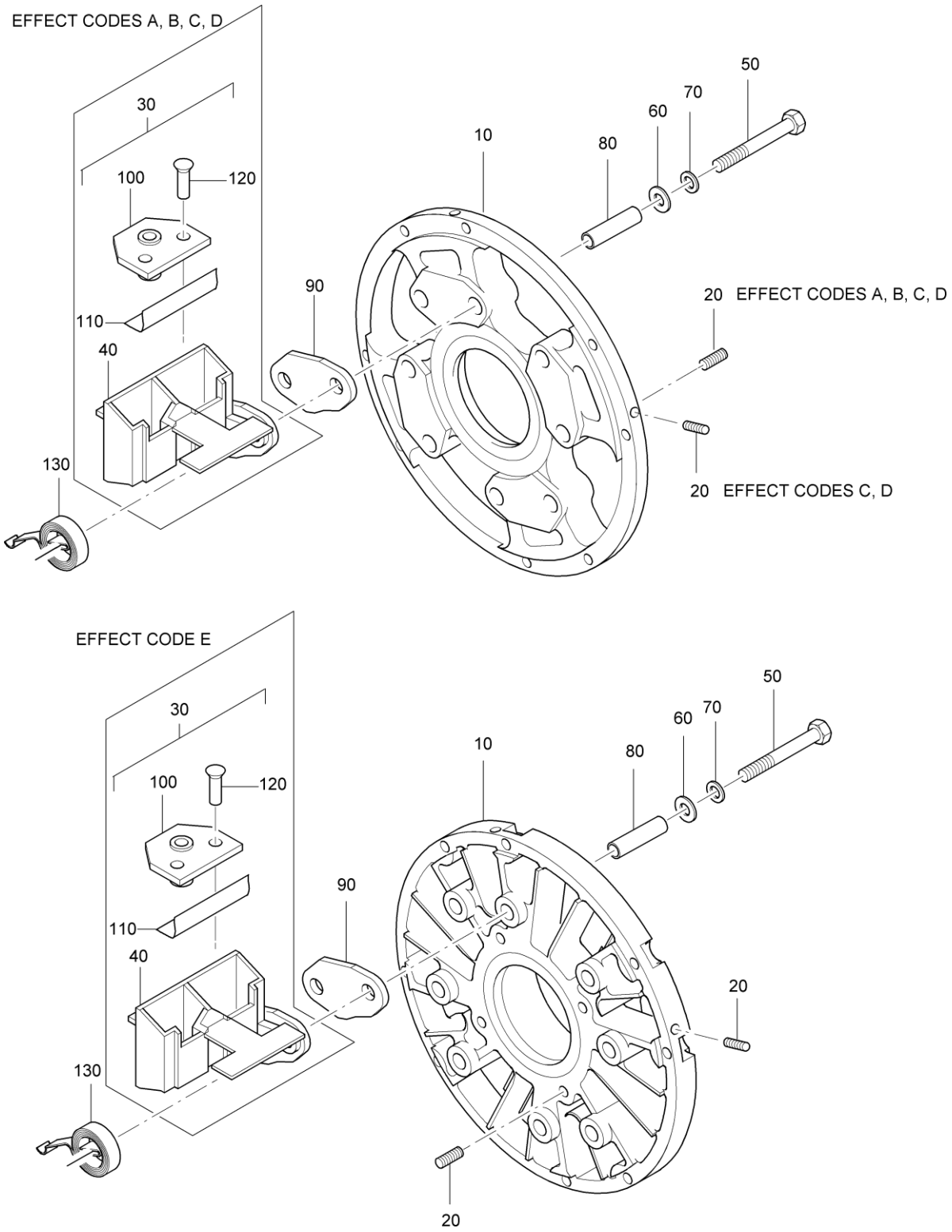


Figure 10002 - Bearing and Brush Support Assembly

| FIGURE AND ITEM | PART NUMBER | NOMENCLATURE<br>1 2 3 4 5 | EFFECT CODE | UNITS PER ASS'Y |
|---|---|---|---|---|
| 10002- | | | | |
| | 23075-333 | SUPPORT ASSEMBLY, Bearing . . . . . and Brush<br>(See IPL Figure 10001 for NHA) | A | RF |
| | 23075-332 | SUPPORT ASSEMBLY, Bearing . . . . . and Brush<br>(See IPL Figure 10001 for NHA) | B | RF |
| | 23065-367 | SUPPORT ASSEMBLY, Bearing . . . . . and Brush<br>(See IPL Figure 10001 for NHA) | C | RF |
| | 23065-366 | SUPPORT ASSEMBLY, Bearing . . . . . and Brush<br>(See IPL Figure 10001 for NHA) | D | RF |
| | 23080-360 | SUPPORT ASSEMBLY, Bearing . . . . . and Brush<br>(See IPL Figure 10001 for NHA) | E | RF |
| 10 | 23072-1100 | • END BELL, Anti-Drive End . . . . . | A,B | 1 |
| | 23072-1360 | • END BELL, Anti-Drive End . . . . . | C,D | 1 |
| | 23080-3050 | • END BELL, Anti-Drive End . . . . . REPLD BY 23080-3055 | E | 1 |
| | 23080-3055 | • END BELL, Anti-Drive End . . . . . REPLS 23080-3050,<br>Refer to SB 23080-360-24-01 | E | 1 |
| 20 | MS21209C0815 | • • INSERT, Helicoil . . . . . | A,B | 4 |
| | MS21209C0815 | • • INSERT, Helicoil . . . . . | C,D | 8 |
| | NAS1130-08L15D | • • INSERT, Helicoil . . . . . ALT: MS21209C0815 | E | 8 |
| 30 | 23075-1204 | • BRUSH HOLDER, Complete . . . . . | A,C | 4 |
| | 23075-1202 | • BRUSH HOLDER, Complete . . . . . | B,D,E | 4 |
| 40 | 23075-1250 | • • BRUSH HOLDER . . . . . | A,C | 4 |
| | 23075-1192 | • • BRUSH HOLDER . . . . . | B,D,E | 4 |
| | | (ATTACHING PARTS) | | |
| 50 | AN3-10A | • BOLT, Machine . . . . . | A,C | 8 |
| | AN3-7A | • BOLT, Machine . . . . . | B,D | 8 |
| | AN3-7A | • BOLT, Machine . . . . . REPLD BY AN3-10A | E | RF |
| | AN3-10A | • BOLT, Machine . . . . . REPLS AN3-7A | E | 8 |
| 60 | 05-374094 | • WASHER, Non-metallic. . . . . | | 8 |

- ITEM NOT ILLUSTRATED

| FIGURE AND ITEM | PART NUMBER | NOMENCLATURE 1 2 3 4 5 | EFFECT CODE | UNITS PER ASS'Y |
|---|---|---|---|---|
| 10002- | | | | |
| 70 | AN960-10L | • WASHER, Flat . . . . . | | 8 |
| 80 | 02-2001-21 | • SLEEVING, Insulation . . . . . REPLD BY 05-631145 | E | 8 |
| | 05-631145 | • SLEEVING, Insulation . . . . . | A,B,C,D | 8 |
| | 05-631145 | • SLEEVING, Insulation . . . . . REPLS 02-2001-21 | E | 8 |
| 90 | 23014-1039 | • BOARD, Insulating . . . . . | A,B,C,D | 4 |
| | 23085-1471 | • BOARD, Insulating . . . . . REPLS 05-651032 | E | 4 |
| | | * | | |
| 100 | 23075-1400 | • • BOARD, Terminal . . . . . | | 4 |
| 110 | 23075-1230 | • • SHEET, Insulation . . . . . | | 4 |
| | | (ATTACHING PARTS) | | |
| 120 | MS20426AD3-5 | • • RIVET . . . . . | | 8 |
| | | * | | |
| 130 | 23072-1130 | • SPRING, Brush . . . . . | | 8 |

- ITEM NOT ILLUSTRATED

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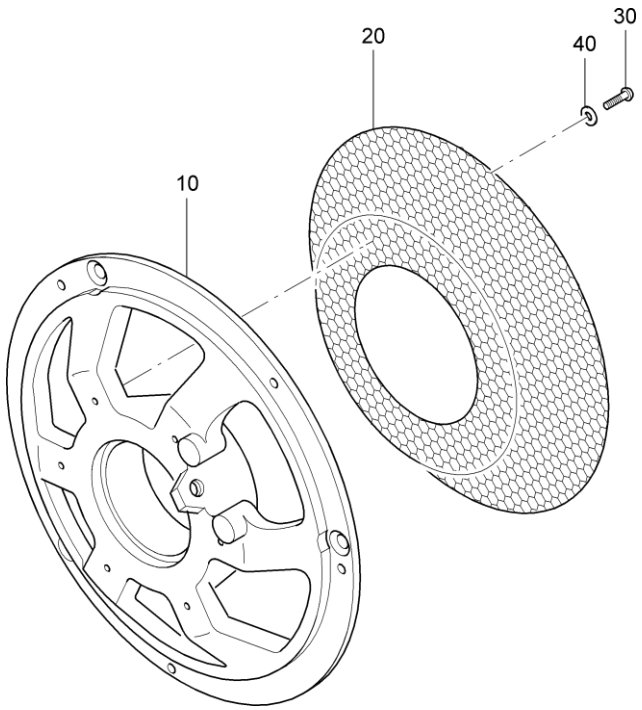
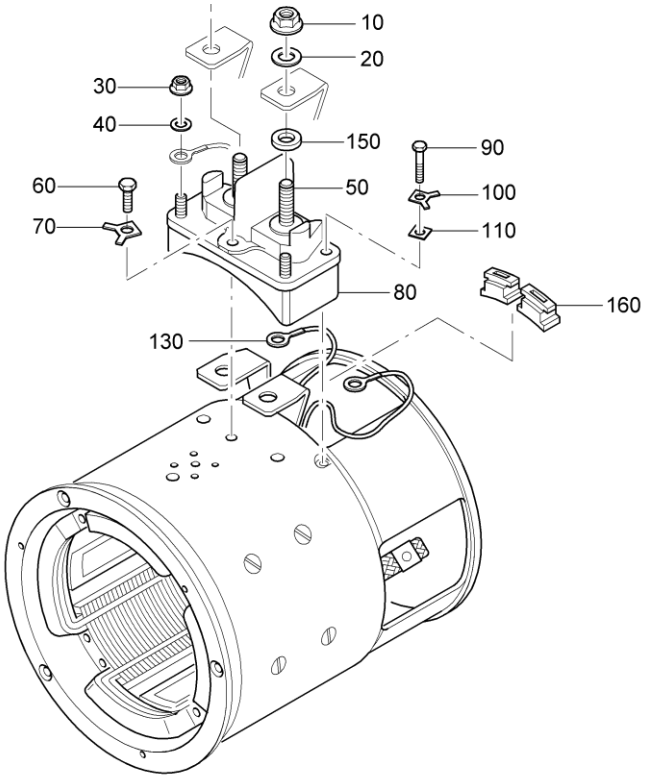



Figure 10003 - Drive End Bearing Support Assembly

| FIGURE AND ITEM | PART NUMBER | NOMENCLATURE<br>1 2 3 4 5 | EFFECT CODE | UNITS PER ASS'Y |
|---|---|---|---|---|
| 10003- | | | | |
| | 23072-1085 | BEARING SUPPORT ASSEMBLY, . . . . . Drive End (See IPL Figure 10001 for NHA) | A | RF |
| | 23080-1348 | BEARING SUPPORT ASSEMBLY, . . . . . Drive End (See IPL Figure 10001 for NHA) | B | RF |
| | 23080-381 | BEARING SUPPORT ASSEMBLY, . . . . . Drive End (See IPL Figure 10001 for NHA) | C | RF |
| | 23080-1351 | BEARING SUPPORT ASSEMBLY, . . . . . Drive End (See IPL Figure 10001 for NHA) | D | RF |
| | 23080-383 | BEARING SUPPORT ASSEMBLY, . . . . . Drive End (See IPL Figure 10001 for NHA) | E | RF |
| | 23080-386 | BEARING SUPPORT ASSEMBLY, . . . . . Drive End (See IPL Figure 10001 for NHA) | F | RF |
| 10 | 23076-1140 | • END BELL, Drive End. . . . . REPLD BY 23080-1070 (**CAUTION**: THE END BELL IS NOT A PART OF DRIVE END BEARING SUPPORT ASSEMBLY P/N 23072-1085. THE END BELL MUST NOT BE ORDERED OR USED AND IS ONLY LISTED AS A REFERENCE) | A | RF |
| | 23080-1070 | • END BELL, Drive End. . . . . REPLS 23076-1140 | A | 1 |
| | 23080-3123 | • END BELL, Drive End. . . . . | B | 1 |
| | 23080-3142 | • END BELL, Drive End. . . . . | C | 1 |
| | 23080-3127 | • END BELL, Drive End. . . . . | D | 1 |
| | 23080-3144 | • END BELL, Drive End. . . . . | E | 1 |
| | 23080-3148 | • END BELL, Drive End. . . . . | F | 1 |
| 20 | 23072-1060 | • GUARD, Screen . . . . . (ATTACHING PARTS) | | 1 |
| 30 | MS21318-15 | • SCREW, Drive. . . . . | | 6 |
| 40 | AN960-4L | • WASHER, Flat . . . . . | | 6 |
| | | ---------- * ---------- | | |

- ITEM NOT ILLUSTRATED

EFFECT CODES A, B, C,




EFFECT CODES D

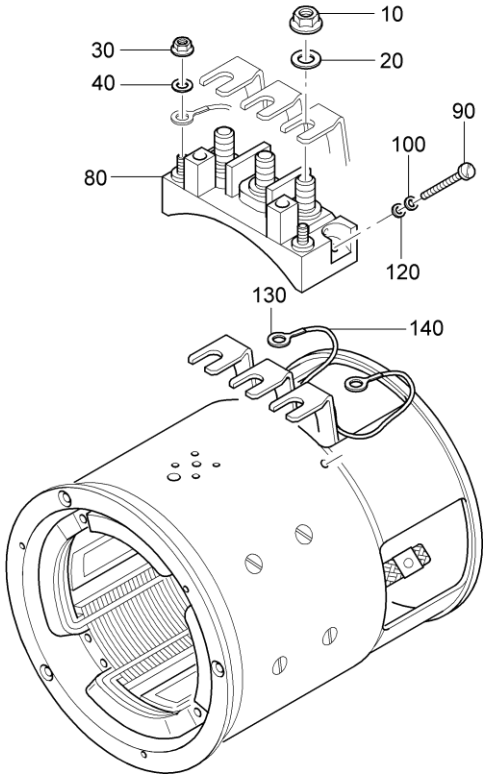



Figure 10004 - Stator and Housing Assembly

| FIGURE AND ITEM | PART NUMBER | NOMENCLATURE<br>1 2 3 4 5 | EFFECT CODE | UNITS PER ASS'Y |
|---|---|---|---|---|
| 10004- | | | | |
| | 23076-332 | STATOR AND HOUSING ASSEMBLY . . .<br>(See IPL Figure 10001 for NHA) | A | RF |
| | 23076-335 | STATOR AND HOUSING ASSEMBLY . . .<br>(See IPL Figure 10001 for NHA) | B | RF |
| | 23076-339 | STATOR AND HOUSING ASSEMBLY . . .<br>(See IPL Figure 10001 for NHA) | C | RF |
| | 23080-324 | STATOR AND HOUSING ASSEMBLY . . .<br>(See IPL Figure 10001 for NHA) | D | RF |
| 10 | MS21043-6 | • NUT, Self-Locking . . . . . .<br>REPLD BY MS21042-6 | A,B | 2 |
| | MS21042-6 | • NUT, Self-Locking . . . . . .<br>REPLS MS21043-6,<br>REPLD BY MS21042L6 | A,B | 2 |
| | MS21042L6 | • NUT, Self-Locking . . . . . .<br>REPLS MS21042-6 | A,B | 2 |
| | MS21042L6 | • NUT, Self-Locking . . . . . | C | 2 |
| | MS21042-6 | • NUT, Self-Locking . . . . . | D | 3 |
| 20 | AN960C616L | • WASHER, Flat . . . . . .<br>REPLD BY AN960C616 | A,B | 2 |
| | AN960C616 | • WASHER, Flat . . . . . .<br>REPLS AN960C616L | A,B | 2 |
| | AN960C616 | • WASHER, Flat . . . . . | C | 2 |
| | NAS1149C0663R | • WASHER, Flat . . . . . .<br>ALT: AN960C616 | D | 3 |
| 30 | AN320-3 | • NUT, Self-Locking . . . . . .<br>REPLD BY MS21042-3 | A,B | 2 |
| | MS21042-3 | • NUT, Self-Locking . . . . . .<br>REPLS AN320-3,<br>REPLD BY MS21042L3 | A,B | 2 |
| | MS21042L3 | • NUT, Self-Locking . . . . . .<br>REPLS MS21042-3 | A,B, | 2 |
| | MS21042L3 | • NUT, Self-Locking . . . . . | C | 2 |
| | MS21042-3 | • NUT, Self-Locking . . . . . | D | 2 |
| 40 | MS35338-43 | • WASHER, Spring Lock . . . . . .<br>REPLD BY AN960C10 | A,B | 2 |
| | AN960C10 | • WASHER, Flat . . . . . .<br>REPLS MS35338-43 | A,B | 2 |
| | AN960C10 | • WASHER, Flat . . . . . | C | 2 |

- ITEM NOT ILLUSTRATED

| FIGURE AND ITEM | PART NUMBER | NOMENCLATURE<br>1 2 3 4 5 | EFFECT CODE | UNITS PER ASS'Y |
|---|---|---|---|---|
| 10004- | | | | |
| 40 (Cont'd) | NAS1149C0363R | • WASHER, Flat . . . . . ALT: AN960C10 | D | 2 |
| 50 | 05-360065 | • STUD . . . . . SUPSD BY 02-4082-07 | A,B | RF |
| | 02-4082-07 | • STUD . . . . . SUPSDS 05-360065 REPLD BY 02-4089-07 | A,B | 2 |
| | 02-4082-07 | • STUD . . . . . REPLD BY 02-4089-07 | C | 2 |
| | 02-4089-07 | • STUD . . . . . REPLS 02-4082-07 | A,B,C | 2 |
| 60 | AN4-4A | • BOLT . . . . . REPLD BY AN4-5A | A,B | 1 |
| | AN4-5A | • BOLT . . . . . REPLS AN4-4A | A,B | 1 |
| | AN4-5A | • BOLT . . . . . | C | 1 |
| 70 | G25-158 | • WASHER, Tab Lock . . . . . | A,B,C | 1 |
| 80 | 23076-1180 | • BLOCK, Terminal . . . . . | A,B,C | 1 |
| | 23079-1040 | • BLOCK, Terminal, Filter Assembly . . . . | D | 1 |
| | | (ATTACHING PARTS) | | |
| 90 | AN3-10A | • BOLT, Machine . . . . . | A,B,C | 2 |
| | MS35266-64 | • SCREW, Machine, Fillister Head . . . . . | D | 2 |
| 100 | G25-157 | • WASHER, Tab Lock . . . . . | A,B,C | 2 |
| | MS35338-43 | • WASHER, Spring Lock . . . . . | D | 2 |
| 110 | G25-171 | • INSULATION. . . . . | A,B,C | 2 |
| 120 | NAS1149C0332R | • WASHER, Flat . . . . . ALT: AN960C10L | D | 2 |
| | | * | | |
| 130 | 05-652015 | • LUG, Terminal . . . . . | | 2 |
| 140 | 15-014021 | • INSULATION, Sleeving, Black . . . . . | D | AR |
| 150 | 02-4203-05 | • WASHER, Flat, Stainless Steel . . . . . | A,B,C | 2 |
| 160 | G300-256 | • GROMMET, Insulator . . . . . | A,B,C | 2 |

- ITEM NOT ILLUSTRATED

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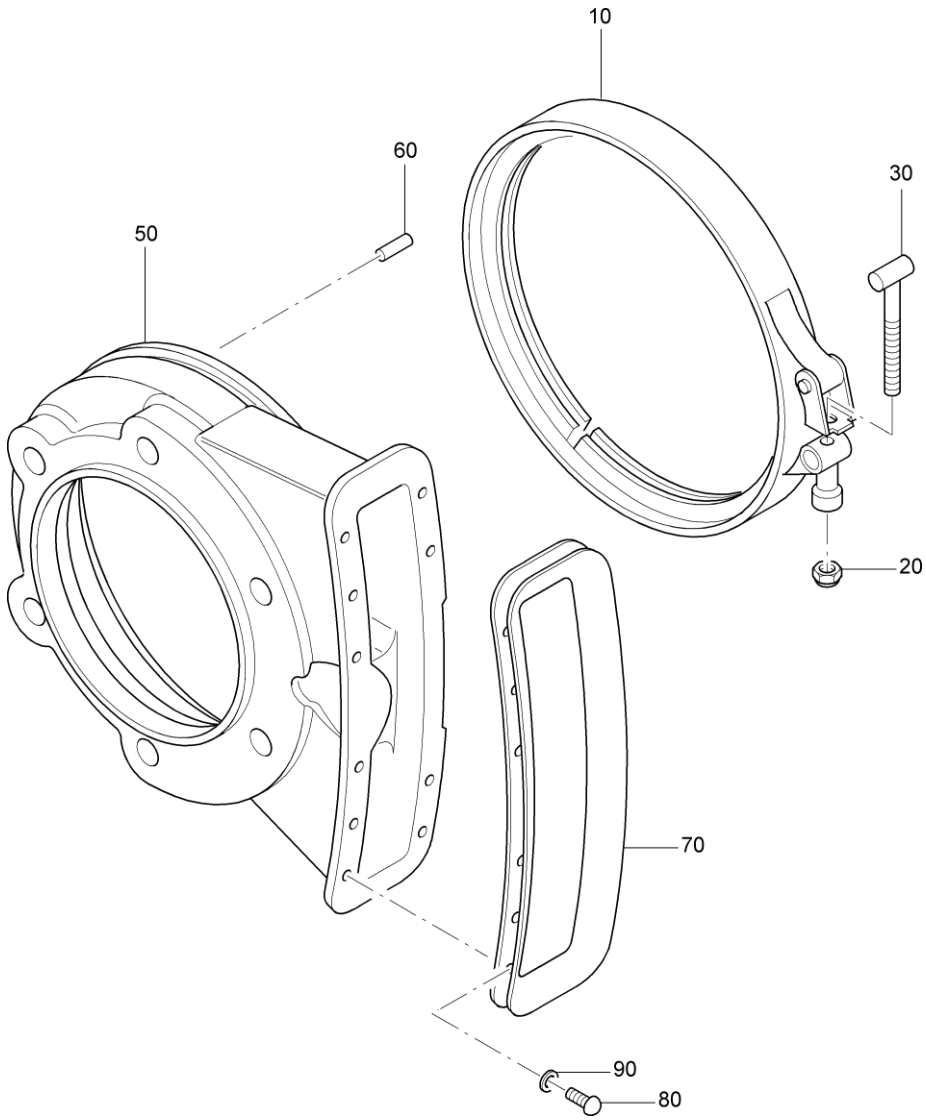


Figure 10005 - QAD Mounting Kit

| FIGURE AND ITEM | PART NUMBER | NOMENCLATURE<br>1 2 3 4 5 | EFFECT CODE | UNITS PER ASS'Y |
|---|---|---|---|---|
| 10005- | | | | |
| | 23080-500 | KIT, QAD (Quick-Attach-Detach) . . . . . .<br>Mounting<br>Can be used on 23080-002 and 23080-058 | A | RF |
| | 23080-501 | KIT, QAD (Quick-Attach-Detach) . . . . . .<br>Mounting<br>Can be used on 23080-004 and 23080-058 | B | RF |
| | 23080-503 | KIT, QAD (Quick-Attach-Detach) . . . . . .<br>Mounting<br>Can be used on 23080-023, 23080-023A, 23080-023B and 23291-005 | C | RF |
| | 23080-504 | KIT, QAD (Quick-Attach-Detach) . . . . . .<br>Mounting<br>Can be used on 23080-056 SUPSD BY 23080-509 | D | RF |
| | 23080-509 | KIT, QAD (Quick-Attach-Detach) . . . . . .<br>Mounting<br>Can be used on 23080-056 SUPSDS 23080-504 | E | RF |
| | 23080-524 | KIT, QAD (Quick-Attach-Detach) . . . . . .<br>Mounting<br>Can be used on 23080-059, 23291-006 and 23291-007 | F | RF |
| | 23080-526 | KIT, QAD (Quick-Attach-Detach) . . . . . .<br>Mounting<br>Can be used on 23080-059, 23291-006 and 23291-007 | G | RF |
| | 23080-527 | KIT, QAD (Quick-Attach-Detach) . . . . . .<br>Mounting<br>Can be used on 23080-023B and 23291-005 | H | RF |
| | 23080-528 | KIT, QAD (Quick-Attach-Detach) . . . . . .<br>Mounting<br>Can be used on 23080-023B and 23291-005 | J | RF |
| | 23080-529 | KIT, QAD (Quick-Attach-Detach) . . . . . .<br>Mounting<br>Can be used on 23080-059, 23291-006 and 23291-007 | K | RF |

- ITEM NOT ILLUSTRATED

| FIGURE AND ITEM | PART NUMBER | NOMENCLATURE<br>1 2 3 4 5 | EFFECT CODE | UNITS PER ASS'Y |
|---|---|---|---|---|
| 10005- | | | | |
| | | (ATTACHING PARTS) | | |
| 10 | 23072-1120 | • COUPLING, V-Retainer. . . . . REPLD BY 23072-1127 | A | 1 |
| | 23072-1125 | • COUPLING, V-Retainer. . . . . ALT: 23072-1325 | E | 1 |
| | 23072-1126 | • COUPLING, V-Retainer. . . . . ALT: 23072-1326 | D | 1 |
| | 23072-1127 | • COUPLING, V-Retainer. . . . . ALT: 23072-1120 and 23072-1327, REPLS 23072-1120 | A | 1 |
| | 23072-1127 | • COUPLING, V-Retainer. . . . . ALT: 23072-1327 | B,C,F,G H,J,K | 1 |
| 20 | MS21045-4 | • • NUT, Self-Locking, Hexagon . . . . . ALT: MS21045L4 | | 1 |
| 30 | 23032-2802 | • • T-BOLT . . . . . ALT: 23032-2803 | | 1 |
| | | * | | |
| -40 | 23080-1030 | • ADAPTER AND SEAL ASSEMBLY . . . | A | 1 |
| | 23080-1110 | • ADAPTER ASSEMBLY. . . . . | B | 1 |
| | 23080-1035 | • ADAPTER AND SEAL ASSEMBLY . . . | C | 1 |
| | 23080-1210 | • ADAPTER ASSEMBLY. . . . . | D | 1 |
| | 23080-1211 | • ADAPTER ASSEMBLY. . . . . | E | 1 |
| | 23080-2060 | • ADAPTER AND SEAL ASSEMBLY . . . | F | 1 |
| | 23080-2061 | • ADAPTER AND SEAL ASSEMBLY . . . | G | 1 |
| | 23080-1037 | • ADAPTER AND SEAL ASSEMBLY . . . | H | 1 |
| | 23080-1038 | • ADAPTER AND SEAL ASSEMBLY . . . | J | 1 |
| | 23080-2062 | • ADAPTER AND SEAL ASSEMBLY . . . | K | 1 |
| 50 | 23080-1010 | • • ADAPTER, Mounting. . . . . | A | 1 |
| | 23080-1011 | • • ADAPTER, Mounting. . . . . | C | 1 |
| | 23080-2090 | • • ADAPTER, Mounting. . . . . | F | 1 |
| | 23080-2091 | • • ADAPTER, Mounting. . . . . | G | 1 |
| | 23080-1013 | • • ADAPTER, Mounting. . . . . | H | 1 |
| | 23080-1014 | • • ADAPTER, Mounting. . . . . | J | 1 |
| | 23080-2092 | • • ADAPTER, Mounting. . . . . | K | 1 |
| 60 | 02-4412-03 | • • PIN, Grooved, Headless . . . . . REPLD BY 02-4412-06 | B | 3 |

- ITEM NOT ILLUSTRATED

| FIGURE AND ITEM | PART NUMBER | NOMENCLATURE<br>1 2 3 4 5 | EFFECT CODE | UNITS PER ASS'Y |
|---|---|---|---|---|
| 10005- | | | | |
| 60 (Cont'd) | 02-4412-06 | • • PIN, Grooved, Headless . . . . . REPLS 02-4412-03 | B | 3 |
| | 02-4412-04 | • • PIN, Grooved, Headless . . . . . | D,E | 3 |
| | 02-4412-04 | • • • PIN, Grooved, Headless . . . . . REPLD BY 02-4412-03 | A,C | 3 |
| | 02-4412-03 | • • • PIN, Grooved, Headless . . . . . REPLS 02-4412-04, REPLD BY 02-4412-06 | A,C | 3 |
| | 02-4412-06 | • • • PIN, Grooved, Headless . . . . . REPLS 02-4412-03 | A,C | 3 |
| | 02-4412-06 | • • • PIN, Grooved, Headless . . . . . | H,J | 3 |
| 70 | 23080-1020 | • • SEAL . . . . . | A | 1 |
| | 23080-1025 | • • SEAL . . . . . | C,F,G,H, J,K | 1 |
| | | (ATTACHING PARTS) | | |
| 80 | MS21318-14 | • • SCREW, Drive . . . . . | C,F,G,H, J,K | 12 |
| 90 | AN960-XC3L | • • WASHER, Flat . . . . . | C,H,J | 12 |
| | NAS1149CN316B | • • WASHER, Flat . . . . . ALT: AN960-XC3L | F,G,K | 12 |
| | | * | | |

- ITEM NOT ILLUSTRATED

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