



**ZEE Systems, Inc.**

**COMPONENT MAINTENANCE MANUAL Z99-800**

***Component***  
***Maintenance***  
***Manual***  
  
***with***  
***Illustrated Parts List***  
  
***for***  
  
***Z99-800-Series***  
***Compressor Drive Motor***



**ZEE Systems, Inc.**

**COMPONENT MAINTENANCE MANUAL Z99-800**

***Record of Revisions***

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\* INTITIAL RELEASE 1-15-03



## **ZEE Systems, Inc.**

### **COMPONENT MAINTENANCE MANUAL Z99-800**

#### **1.0 INTRODUCTION**

1.1 **PURPOSE:** The primary purpose of the Z99-800-SERIES Motor is to drive the compressor of the vapor cycle air conditioning system. This motor is designed to provide a constant speed power source with high torque starting characteristics.

1.2 **DESCRIPTION:** The Z99-800 drive motor operates on 28 VDC supplied by the aircraft electrical system. The motor is compound wound with high torque starting characteristics and is designed for operation up to 35,000 feet altitude. The motor is equipped with an internal fan and is self cooled. Some applications may have additional ram air supplied for supplemental cooling capability.

1.3 **SERVICE LIFE:** This motor has a service life of 2,000 hours (Hobbs meter) and should be overhauled at that time. The brushes should be inspected every 500 hours (Hobbs meter). Refer to TABLE 5-1 for service and overhaul schedules.

#### **NOTE**

***Throughout this manual reference is made to the Illustrated Parts List.  
The figure and item referenced are shown in parenthesis (fig-item) in the text.***

#### 1.4 **LEADING PARTICULARS:** See TABLE 1-1

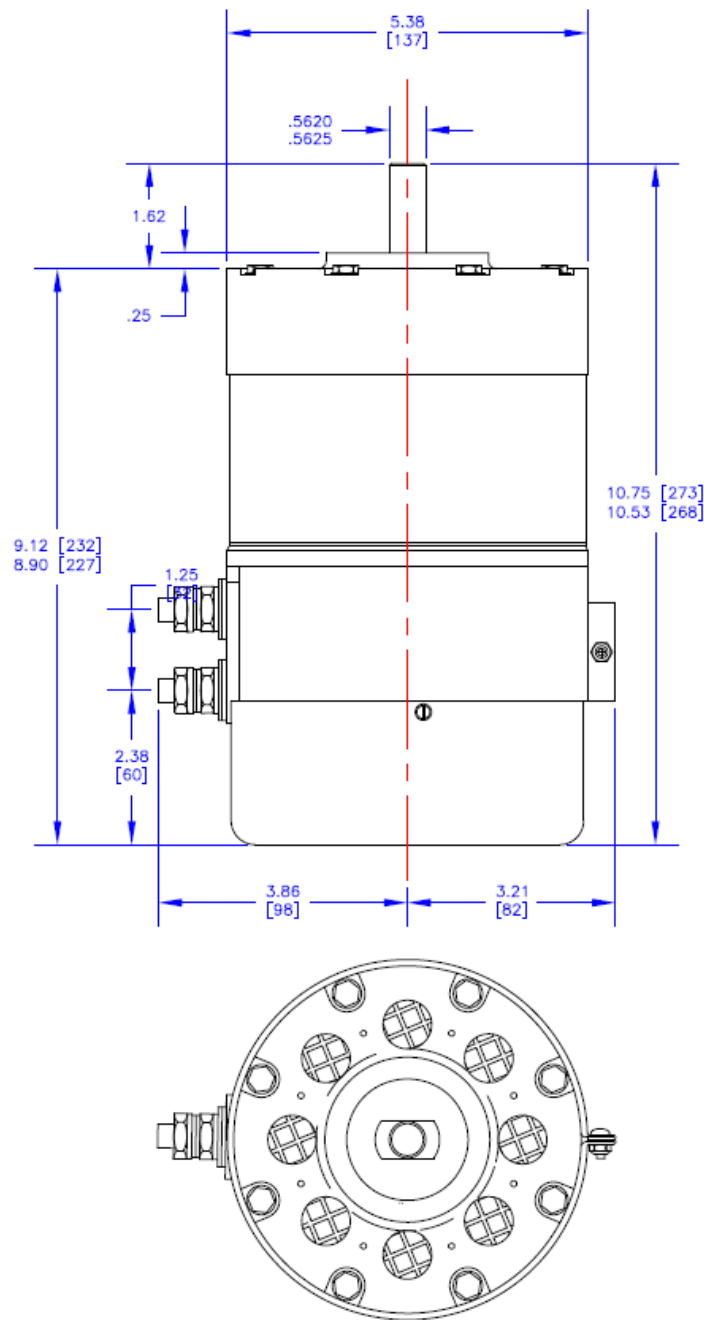
|                                       |                       |
|---------------------------------------|-----------------------|
| Horsepower - Rating.....              | 3.75                  |
| Duty .....                            | Continuous            |
| Torque - Pound-Feet.....              | 2.9 lb.-ft. (3.9 N-m) |
| Voltage - Direct Current.....         | 27-30                 |
| Load - Continuous (Amperes).....      | 150                   |
| RPM - No Load (min) .....             | 7,500                 |
| RPM @ 2.9 LB-FT Torque (min).....     | 8,000                 |
| Cooling.....                          | Internal Fan          |
| Rotation - Viewed from drive end..... | CW                    |
| Overall Length - Inches.....          | 10.75 (273mm)         |
| Weight - Approximate net.....         | 20 Lbs. (9.07 Kgs.)   |

TABLE 1-1



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**COMPONENT MAINTENANCE MANUAL Z99-800**




Z99-800-1 Dimensions

ILLUSTRATION 1



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SAN ANTONIO, TX, USA  
MOTOR ASSEMBLY, D.C.

P/N

S/N  28 VDC CONT

MODS  AMPS

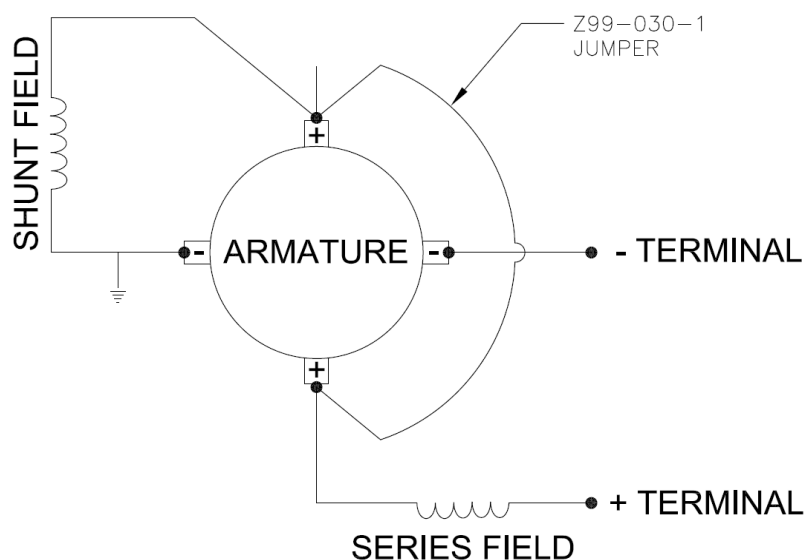
259179-1  
PLACARD

ROTATION 

MODIFICATIONS  
WILL BE MARKED  
IN THIS BLOCK.

Modification Status Is Important  
When Ordering Parts

ILLUSTRATION 2



Motor Schematic Wiring Diagram

ILLUSTRATION 3



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**2.0 MATERIALS, SPECIAL TOOLS AND TEST EQUIPMENT**

2.1 MATERIALS REQUIRED FOR OVERHAUL are listed in TABLE 2-1.

NOTE: Equivalent materials may be used for items listed.

| MATERIAL   | SOURCE                 |
|--|------------------------|
| Cleaning Solvent<br>FED SPEC P-D-680<br>Type I, "Stoddard Solvent"<br>Type II, "140F Solvent"<br>or other biodegradable solvents<br>or agents which will not<br>attack the metal, non-metallic<br>components or the electrical insu-<br>lation or varnish. | Commercially available |
| Degreaser  | Commercially available |
| Loctite, Grade D   | Loctite Corporation    |
| Chemical Film Solution<br>Alodine 1200<br>Turco 4178<br>Iridite 14-2   | Commercially available |
| Sandpaper  | 320 grit or finer      |
| Cleaning Pads, lint-free, soft<br>cotton   | Commercially available |
| Bristle Brush, soft (non-metallic)   | Commercially available |

TABLE 2-1

2.2 EQUIPMENT AND SPECIAL TOOLS required for Overhaul and repair are listed in TABLE 2-2.

NOTE: Equivalent tools may be used for items listed. See APPENDIX A for data to fabricate fixtures.





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| EQUIPMENT / SPECIAL TOOLS  | SOURCE                 |
|--|------------------------|
| SZ58100 Spanner Wrench   | ZEE Systems, Inc.      |
| SZ58T102 Fixture   | ZEE Systems, Inc.      |
| SZ58T103 Fixture   | ZEE Systems, Inc.      |
| SZ58T104 Fixture   | ZEE Systems, Inc.      |
| SZ58T105 Fixture   | ZEE Systems, Inc.      |
| SZ58T106 Fixture   | ZEE Systems, Inc.      |
| SZ58T107 Fixture, Locked Rotor                                     | ZEE Systems, Inc.      |
| Lathe, engine  | Commercially available |
| Undercutting mill  | Commercially available |
| Rotor Balancing Machine capable of measuring 10 grain-inches       | Commercially available |
| High Potential Tester capable of 220 VAC rms, 60 Hz for one minute | Commercially available |
| Growler with test light.   | Commercially available |
| Micrometer 0-1.0000"<br>2-3.000"                                   | Commercially available |
| Dial Indicator 0-0.3000"   | Commercially available |
| Spring Scale 0-60 oz.  | Commercially available |
| Puller, bearing  | Commercially available |
| Arbor Press  | Commercially available |

TABLE 2-2



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2.3 TEST EQUIPMENT required for Airworthy-Return to Service Certification is listed in TABLE 2-3.

| EQUIPMENT   | SOURCE                 |
|---|------------------------|
| D.C. Power Source, variable capable of<br>28 VDC @ 200 Amps (continuous)      | Commercially available |
| Tachometer, Strobe or Photo tach capable of<br>measuring 10,000 RPM (minimum) | Commercially available |
| Temperature Measuring Device<br>0-300F range (rapid response)                 | Commercially available |
| D.C. Voltmeter, 0-35 volt range   | Commercially available |
| D.C. Ammeter 0-600 ampere range   | Commercially available |
| High Potential Tester capable of<br>220 volts AC rms, 60Hz for<br>one minute. | Commercially available |

TABLE 2-3



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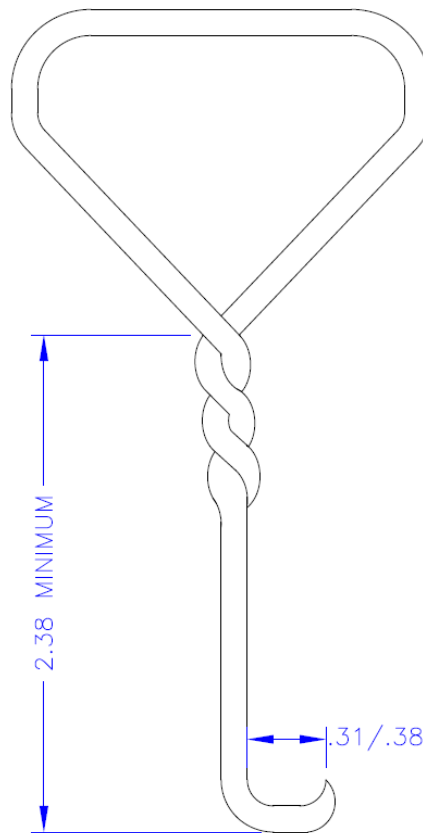
**COMPONENT MAINTENANCE MANUAL Z99-800**

**3.0 REPAIR AND OVERHAUL**

3.1 MOTOR DISASSEMBLY: After the motor has been removed from the aircraft and the mounting frames. Remove the:

3.1.1 BRUSH BANDS (1-6/-7) by removing screw and nut (1-43/-45). Unhook the bands from the commutator end bell (1-9/-10)

3.1.2 BRUSHES. Obtain a short length of stiff wire and form a right angular hook tool approximately .25" on one end. Using this hook, lift the brush springs and slide the brushes from the holder. Remove the four screws (1-21). Note the location of each brush. If the brushes are to be reused, they must be installed in the same holder. These screws also attach the stator coil terminals and jumper (2-2).



Wire Hook Tool  
ILLUSTRATION 4



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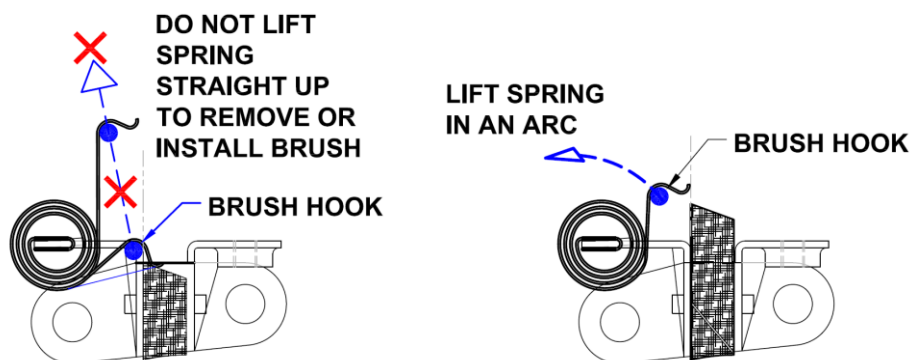


ILLUSTRATION 5

3.1.3 FAN COVER ( 1-4). Loosen and remove the four screws (1-30) and washers (1-35 ). One will also hold the clamp (1-50).

3.1.4 FAN (1-12). Using a SZ58T101 socket spanner remove the round nut (1-20/-42 ) and lock washer (1-19/-43). Walk the fan (1-12) off the armature shaft and recover the key (1-23).

3.1.5 DRIVE END (D.E.), END BELL (1-8/-53). Remove the bolts (1-27/-35/-38) and washers which attach the drive end bell to the stator (1-11/-51). On the commutator end remove the screws and washers from the bearing retainer. Lay the motor horizontal and hold the stator with one hand. Using a rawhide or plastic mallet, tap the shaft on the commutator end of the armature (1-5/-41) until the armature is free of the commutator end bell (1-8/-53). Take care not to damage the commutator on the armature. In most cases the bearing on the commutator side will remain on the armature shaft. Occasionally the bearing will stay in the commutator end bell. Either case is okay.

3.1.6 ARMATURE (1-5/-41). Separate the armature (1-5/-41) from the drive end bell (1-8/-53). If necessary support the drive end bell with two wood blocks slightly longer than the armature and press the armature and bearing out of the end bell using an arbor press. After separating the armature from the drive end housing use a bearing puller to remove the drive end bearing (1-13) from the armature, discard bearing. Take care not to damage the internal threads on the armature drive end shaft. Remove the Commutator end (Anti-Drive End A.D.E.) bearing (1-14) bearing from the armature in the same manner. Save the inner bearing retainer for reassembly.

3.1.7 COMUTATOR (Anti-Drive End, A.D.E.) END BELL (1-9/-10). To remove the bearing from the commutator end bell, use a rawhide or plastic mallet to tap out the bearing, or press the bearing from the end bell using an arbor press, discard bearing.

3.1.7.1 Only separate the stator and commutator end bell if required for repair or replacement. To separate the commutator end bell from the stator (1-11/-51), remove the bolt and washers (1-31/-35) from the copper stator lead to the positive stud on the end bell, then remove the screws and washers (1-29/-36/-39). Using a rawhide or plastic mallet lightly tap the stator housing. To remove the bearing retainers (1-17/-18/-19) loosen and remove the four screws (1-22/-34). Press the bearing (1-14) out of the housing using an arbor press.



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3.1.7.2 Inspect the motor components in accordance with Table 3-1. Only disassemble commutator end bell far enough to make needed repairs.

3.2 INSPECTION: Refer to TABLE 3-1 for inspection criteria and dimensional tolerances.

#### **WARNING**

***HIGH POTENTIAL TESTING IS CONSIDERED HAZARDOUS.  
USE EXTREME CARE AND AVOID CONTACT WITH THE TEST PROBES  
OR ITEMS BEING CHECKED WHEN PERFORMING THESE TESTS. ONLY  
TRAINED PERSONNEL QUALIFIED AND FAMILIAR WITH THE PROPER  
OPERATION OF THE TEST EQUIPMENT SHOULD PERFORM THESE TESTS.***

#### **NOTE**

***The armature, stator and commutator end bell must be clean and free of carbon dust before performing these checks.***

3.2.1 ARMATURE: Tests and inspections during overhaul before assembly.

3.2.1.1 Using the test circuit attach one lead to the shaft and the other to 1) the commutator risers, then 2) to each of the balance bands, then 3) to the laminations. Attach one lead to the commutator risers and the other to 1) each of the balance bands, then 2) laminations. If the test lamp lights during any of these checks the armature must be replaced.

3.2.1.2 Check for short circuits by using a growler. Move a piece of steel, such a hack saw blade, loosely over the laminations. If the steel is attracted to any point of the armature, there is a short circuit, and the armature must be replaced.

3.2.1.3 Conduct a high potential test between the armature shaft and the commutator risers at 220 VAC rms, 60 Hz for five seconds. Check between each of the balance bands to the commutator risers. No evidence of insulation breakdown shall occur as a result of these tests. If, breakdown occurs, the armature must be replaced.

3.2.1.4 Check dimensional tolerances shown in TABLE 3-1.

3.2.2 STATOR: Tests during overhaul before assembly.

3.2.2.1 Check for grounds, attach one end of the test lamp to the housing and the other to each of the copper leads and the white shunt wires. If lamp lights, there is a short. Replace the stator.

3.2.2.2 Check for open circuits, attach the two-test lamp leads to the small flexible shunt wires. If the lamp does not light, there is an open circuit. Replace the Stator. Repeat for the two copper leads.

3.2.2.3 Check the resistance between the white shunt windings. Resistance should be 8.8-9.2 ohms. Replace stator if out of out of tolerance.



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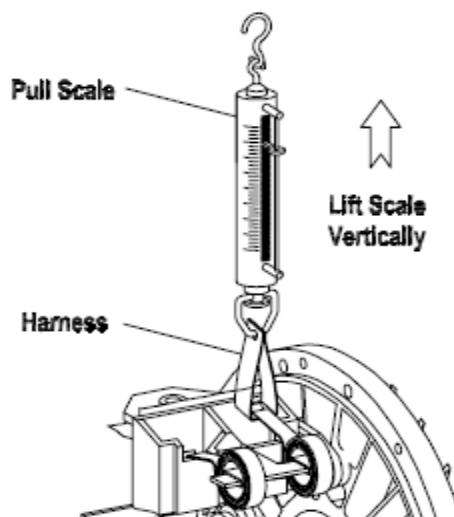
3.2.3 COMMUTATOR END BELL (A.D.E.): Tests during overhaul before assembly.

3.2.3.1 Check for grounds, attach one end of the test lamp to the housing and the other to the positive brush holder. If lamp lights, there is a short. Repair the insulating components.

3.2.3.2 Check for open circuits, attach one of the two test lamp leads to the housing and the other to the negative brush holder. If the lamp does not light, there is an open circuit. Repair to make the ground complete.

3.2.3.3 Check dimensional tolerances shown in TABLE 3-1.

3.2.4 BRUSH SPRING: Check brush spring tension by inserting a small hoop of wire under the tang of spring. Raise spring by means of a scale to a height of approximately  $\frac{1}{4}$  to  $\frac{3}{8}$  inch (6,35 to 9,53 mm). In this position spring tension should be between 32 and 52 ounces (.91 and 1.48 kg). Replace any spring whose tension is not within this range



Brush Spring Tension Check  
ILLUSTRATION 6

3.2.5 BRUSH HOLDER: Inspect for cracks or warpage. Check that a new brush will slide in and out easily with no binding. Replace if defective.

3.2.6 RETAINER: Inspect for cracks, dents, wear, warpage or other defects. Replace if defective.

3.2.7 RETAINER: Inspect for cracks, dents, wear, warpage or other defects. Check that nuts are tight on plate. Replace if damaged or defective.



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| ITEM | DESCRIPTION                | INSPECTION  | TOLERANCE / ACTION  |
|------|----------------------------|---|---|
|      | Brush Cover                | Check for dents or cracks.<br>Check insulation for damage.                                    | Replace if defective.<br>Replace if defective.  |
|      | Brush                      | Check for cracks, chips, frayed leads and loose rivets or shunt connections.<br>Check length. | Replace if defective.<br><br>Minimum is .750. Replace as necessary.<br><br>Replace brushes if remaining allowable wear will be exceeded before next inspection or overhaul. |
|      | Brush Spring               | Check the tension on each spring.   | Replace any spring that does not take 38-48 ounces of tension to raise .25-.38 inches.  |
|      | Brush Holder               | Check for cracks or distortion.   | Holders must be square where  |
|      | Fan                        | Check for dents or cracks.<br>Check bore diameter.  | Replace if defective.<br>Replace if bore more than .6715.   |
|      | Jumper                     | Test for short or open.<br>Check for frayed or damaged leads or insulation.                   | Replace if defective.<br>Replace if defective.  |
|      | End Bell, Drive End (D.E.) | Check for cracks, chips, frayed leads and loose screen or rivets.<br>Measure Bearing liner ID | Replace if defective.<br><br>Replace if ID does not measure 1.8500-1.8505.  |

TABLE 3-1A



## **ZEE Systems, Inc.**

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| ITEM | DESCRIPTION | INSPECTION  | TOLERANCE / ACTION  |
|------|-------------|---|---|
|      | Stator      | <p>Check for breaks or frayed spots in the insulation.</p> <p>Test for grounds, opens, or shorts. Refer to 3.2.2 for procedures.</p>  | <p>Repair any small defects by applying fiberglass sleeving or tape where possible. Paint over frayed or repaired areas with red insulating varnish or glyptal. Allow to dry between coats.</p> <p>Replace stator if defective.</p>   |
|      | Armature    | <p>Check for worn, pitted or burned commutator bars; damaged windings, retainer, threads on shaft.</p> <p>Test for commutator ground. Refer to 3.2.1.1 for instructions.</p> <p>Test for short or open circuits. Refer to 3.2.1.2 for instructions.</p> <p>Check commutator diameter.</p> <p>Check commutator concentricity.</p> <p>Check the shaft bearing journal OD</p> <p>Check that the balance bands are tight.</p> | <p>Replace Armature if any of the commutator bars or windings are damaged.</p> <p>Replace if Armature shows ground.</p> <p>Replace if Armature has shorts or open circuits.</p> <p>Turn and undercut commutator. Replace Armature if after turning commutator the OD is under 2.125. Refer to 3.3.1 for rework procedures.</p> <p>Bar to bar concentricity must be within 0.0002in. and concentricity with shaft must be within 0.0008in. T.I.R</p> <p>Replace Armature if the commutator bearing journal OD does not measure .6692-.6695.</p> <p>Replace Armature if the drive bearing journal OD does not measure .5620-.5625.</p> <p>Replace Armature if bands are damaged or loose.</p> |

TABLE 3-1B





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| ITEM | DESCRIPTION  | INSPECTION   | TOLERANCE / ACTION  |
|------|--|--|---|
|      | End Bell, Anti Drive End.<br>(A.D.E.) or Brush End or Comm End | Check for cracks, chips, frayed leads and loose Brush Holders or connections.<br><br>Check the positive Brush Holders are insulated from Ground.<br><br>Check the negative Brush Holders have continuity to the housing.<br><br>Measure Bearing liner ID | Replace if defective.<br><br>There should be no continuity between the Positive Brush Holder and the housing. Use a voltmeter or test light to check for continuity. Replace insulating components as necessary.<br><br>Ground negative Brush Holders.<br><br>Replace if ID does not measure 1.5747-1.5753. |

TABLE 3-1C

### **3.3 REPAIR AND OVERHAUL.**

#### **3.3.1 ARMATURE**

**3.3.1.1 Turning the Commutator:** If inspection reveals that the commutator is rough, pitted, scored, or burned, refinish in a lathe that is accurately set up and adjusted. Remove only the material necessary to clean and true up the commutator surface. To insure uniformity of surface finish, a diamond tipped cutting tool with a maximum tool tip radius of 0.006 in. (including tool wear) is recommended for making the final surface cut on the commutator. Replace armature if refinished commutator diameter is less than 2.125 inches after refinishing. Hold commutator concentric with bearing journals within 0.0008-inch T.I.R., with bar to bar concentricity within 0.0002 inch.

**3.3.1.2 Undercutting the Mica:** If the depth of the undercut remaining after the turning operation has been completed is less than 0.032 inch, the mica between the commutator bars should be undercut to 0.026 wide and a depth of 0.032 deep. Use a triangular scraper to remove all excess mica, sharp edges, and burrs from between the commutator bars. Use a bristle brush to remove metal chips and mica particles from the slots between the commutator bars. Check for concentricity (4.2.1.).

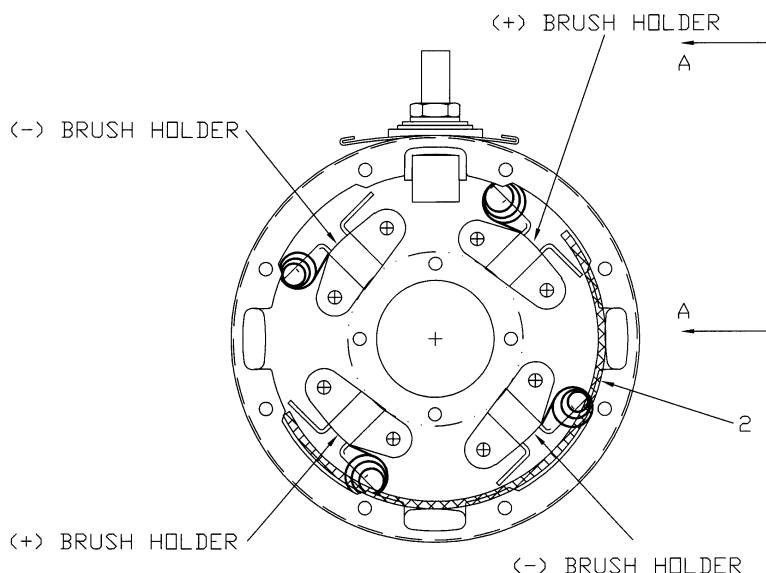


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### **COMPONENT MAINTENANCE MANUAL Z99-800**

3.3.1.3 Armature balancing: After commutator refinishing, check the armature for proper balance, which shall be within 2.7 grain-inches (.006 oz-in) at the commutator end and within 3.4 grain-inches (.008 oz-in) at the drive end. If balance correction is required, mill the stainless-steel retaining bands at each end of lamination stack to a depth no deeper than 0.020 inch and 0.25 wide until the proper degree of balance is obtained. Only two 0.25-inch-wide cuts are permitted in each band to maintain adequate hoop strength.

#### **3.3.2 COMMUTATOR END BELL**



**Commutator End Bell (A.D.E.)  
Viewed open end up**

#### **ILLUSTRATION 6**

3.3.2.1 Brush Holder Assembly replacement: Replace any worn, burnt or defective Brush Holders. There are two Brush Holder part numbers. All four brush holders must be the same part number in the end bell. See ILLUSTRATION 7 or FIG. 8-3.

3.3.2.2 Removal (+) Brush Holder: Loosen nuts (7-7) and remove the two screws (7-12) and washers (7-11) and non-metallic washers (7-8,7-10). Remove holder (7-5) and insulating sleeves (7-9). Remove all insulating enamel residue from the commutator end bell (7-1).

3.3.2.3 Installation (+) Brush Holder: Install brush springs on holder as described in 3.3.3.1. Insert insulation sleeve (7-9) in commutator end bell (7-1). Place 2 washers (7-10/-26) on screw (7-12) and insert screws through insulation sleeves (7-9). Stack the non-metallic



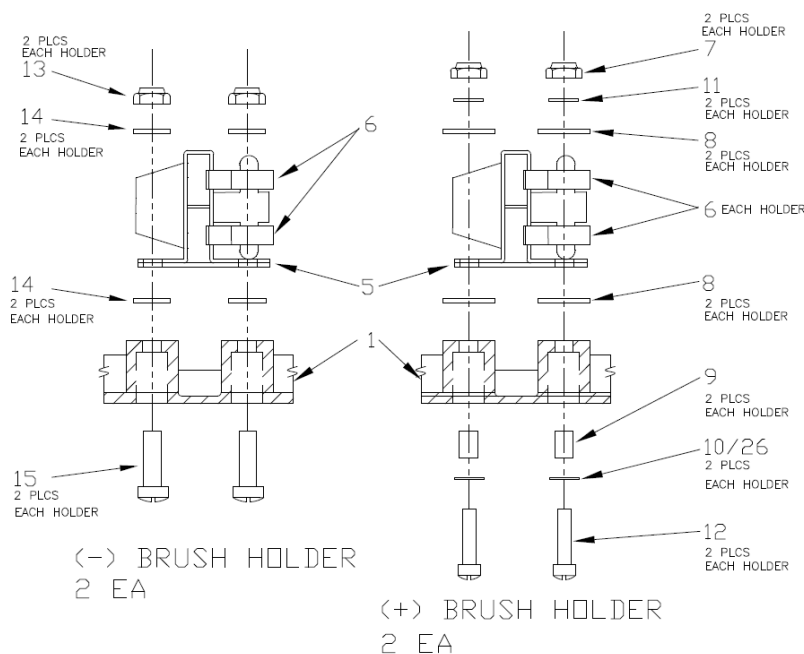
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washers (7-8) then the holder (7-5), then non-metallic washers (7-8) and then washers (7-11), secure with nuts (7-7). Tighten to 20-25 in-lbs. Coat edge of holder (7-5) base, washers (7-8,7-11), nuts (7-7) and screw heads (7-12) with red insulating enamel. Bake housing in an oven for one hour at a temperature of 150F (66C), remove and allow to cool to room temperature.

3.3.2.4 Removal (-) Brush Holder: Loosen nuts (7-13) and remove the two screws (7-15) and washers (7-14). Remove holder (7-5). Remove all insulating enamel residue from the commutator end bell.

3.3.2.5 Installation (-) Brush Holder: Install brush springs on holder as described in 3.3.3.1. Insert screw (7-15) in commutator end bell. Place washer (7-14) on screw then the holder (7-5) then the second washer (7-14) and secure with nuts (7-13). Tighten to 20-25 in-lbs.



Brush Holder Installation  
ILLUSTRATION 7

### 3.3.3 BRUSH SPRING

#### CAUTION

*Do not wind spring further than necessary to install in Position, or spring may take permanent set, and produce Insufficient pressure on brush.*



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3.3.3.1 Brush Spring replacement: REFER to Service Letter SL99-88-3 for more detailed instructions. Remove defective spring from brush holder assembly. Wind the replacement spring approximately  $\frac{3}{4}$  turn and install on the brush holder spring support bar. Check the tension as described in 3.2.4.

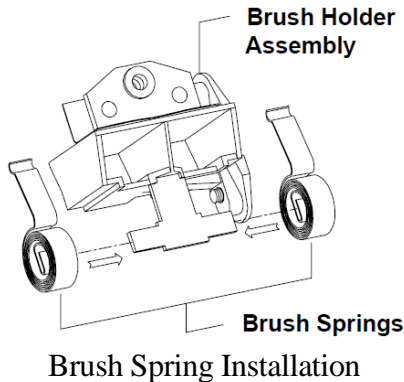


ILLUSTRATION 8

### **3.3.4 BRUSH COVER**

3.3.4.1 Brush Cover insulation replacement: Remove all existing insulation from brush cover(s) (1-14) and thoroughly clean the inside diameter of cover. Apply a single layer of 8 mil acrylic PTFE coated fiberglass insulation with adhesive to the inside diameter flush with the edges and ends of the cover, trim any excess.

3.4 ASSEMBLY: The major components of the motor are the 1) armature, 2) drive end bell, 3) stator, 4) commutator end bell. The minor components are the 1) bearings, 2) retainers, 3) brushes, 4) jumper, and 5) hardware.

3.4.1 Place commutator end bell (1-14/-15/-16) in the arbor press open side down. Start bearing (1-23) into the bearing liner on the commutator end bell. Use SZ58T105 to press the bearing into the liner. This fit is loose. Use caution so the bearing does not fall through the housing when moving it. Place the retainer with threads (1-26/-28) on the inside (open end) of the housing and the retainer (1-27) on the outside. Attach the screws and washers (1-31/-60). Evenly tighten the hardware locking the bearing in place in commutator end bell. Set aside.

3.4.2 If the stator (1-17/-18/-19) is not attached to the commutator end bell attach it at this time. Make sure the positive post on the stator aligns with the positive brush holder (4-5) and the tab from the stator aligns with the positive stud (3-22) on the end bell. Secure with hardware. Set aside.



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3.4.3 Place Fixture SZ58T104 in the arbor press with the small step up. Place drive end bell (1-13/-56/-72) onto the Fixture SZ58T104 open side up. Start bearing in the drive end housing liner. Using SZ58T106 press the bearing into the drive end housing. Remove SZ58T106. Start the armature (1-9/-10/-57/-67) drive end shaft into the bearing. Place SZ58T103 on the commutator shaft and press the armature down onto the drive end bell. Remove the armature drive end unit.

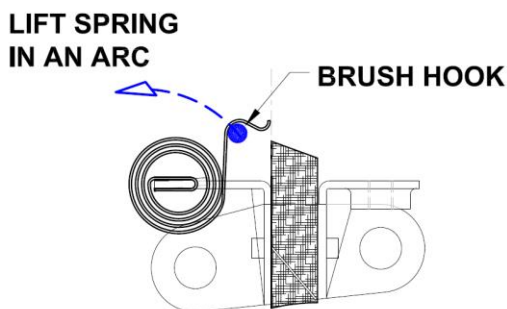
3.4.4 Place fixture SZ58T103 on the arbor press small end up. Place the commutator end bell/stator unit on fixture SZ58T103 open end up. Place the armature/drive end unit into the comm end bearing. Place fixture SZ58T102 on the drive end shaft and press the armature into the bearing until the drive end bell is about 1/32 away from the stator and is free to rotate.

3.4.5 Remove the unit from the arbor press. The drive end is a loose fit so take care to secure the end bell. Start the hardware that attaches the drive end bell to the stator. When the end bell is tight return the unit on fixture SZ58T103 drive end up. Place fixture SZ58T102 on the drive end shaft and press until all bearing are seated on the shoulder.

3.4.6 Turn the armature by hand. It should free and easy to turn. If there is binding use a small rubber mallet and tap the armature shaft on the commutator end. Again, turn the armature. If there is no improvement tap armature shaft on the drive end. Continue this procedure until the armature spins freely. If tapping with the mallet does not improve the binding disassemble the unit to determine and correct the problem.

3.4.7 Place an adjustable wrench on the flats on drive end shaft. Attach fan (1-21). Secure with washer lock (1-25) and nut (1-29). Attach fan cover (1-5/-6/-55). Secure with hardware.

3.4.8 Install the four brushes (1-24). Secure with screws (1-30). Do not attach the brush covers (1-11/-12) until after the unit has been tested.



**ILLUSTRATION 9**



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3.4.9 After the motor has been assembled the new brushes must be “run in” until each brush is seated 100 percent across the radius of the brush (where the brush meets the commutator) in the direction of rotation and at least 75 percent in the axial direction.

**WARNING**

***INJURY COULD OCCUR IF THE MOTOR IS NOT SECURED AT START UP.***

***THE Z99-800 MOTOR IS A HIGH TORQUE MOTOR.***

***DO NOT APPLY FULL VOLTAGE AT START UP.***

3.4.10 Brush Seating – Preliminary. THIS PROCEDURE MUST BE USED WHEN INSTALLING THE Z6386C BRUSH. Cut a strip of sandpaper 320 grit or higher just slightly wider than the commutator surface with a length of  $\frac{1}{2}$ ” more than the circumference of the commutator, approximately 7.75 inches long. Attach the sandpaper to the commutator with masking tape so the rough side will contact the brush in such a manner that the taped end will be in the direction of rotation. Leave the other end loose. The loose end will overlap the masking tape so that when the armature is rotated the brush will ride off loose end and onto the taped end of the sandpaper.

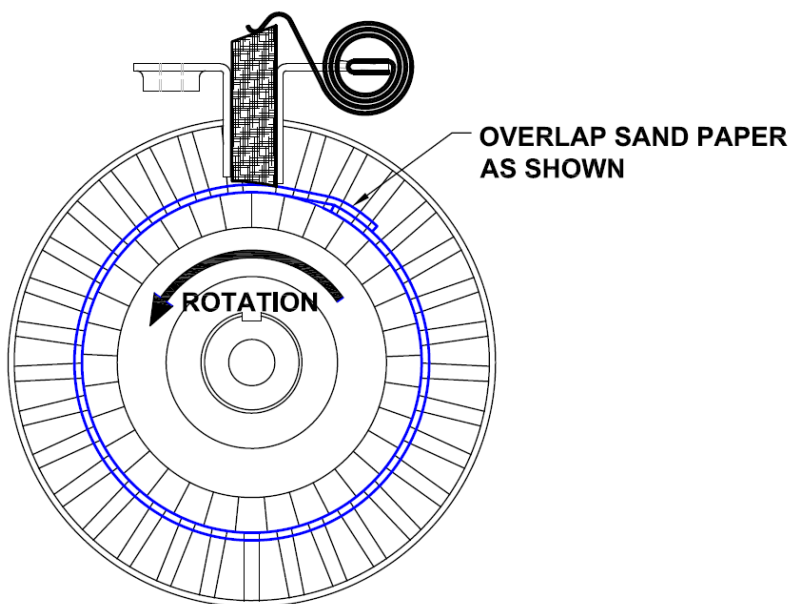


ILLUSTRATION 10

Slowly rotate the armature by hand until the basic shape of the commutator arc is worn into the brush. Usually takes 30-40 revolutions. When the brush has the same arc as the commutator move the brushes away from the commutator and remove the sandpaper. Use



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light compressed air to remove any carbon dust. Gently lower the brushes onto the commutator.

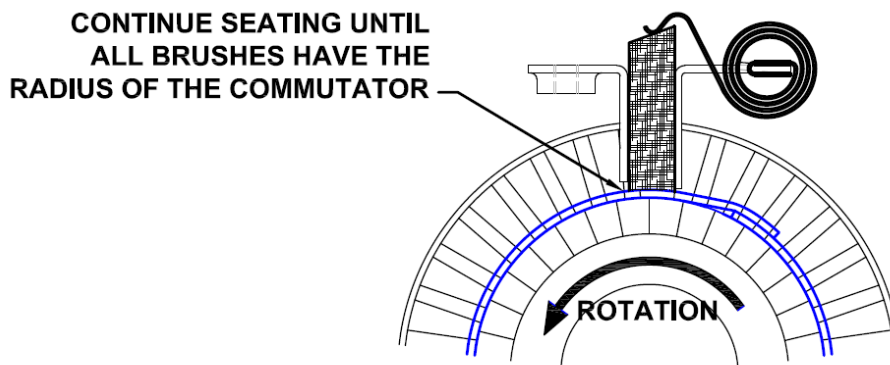


ILLUSTRATION 11

3.4.11 Brush Seating. Connect the motor to a power supply capable of 50A @ 28VDC. Secure the motor. Slowly apply voltage so the motor does not jump until 26-28VDC is attained. It is normal for some minor arcing between the brush(es) and the commutator. As the brushes seat the arcing will stop. Do not continue if the arcing is excessive or becomes worse. This may be a sign of an electrical problem with the armature or commutator. After about a minute install the brush bands so proper internal cooling air flow will occur. Operate the motor with no load until each brush is seated 100 percent across the face of the brush (where the brush meets the commutator) in the direction of rotation and at least 75 percent in the axial direction. This may take several hours depending on the initial surface of the brushes. The motor should be run until the commutator has a smooth even glaze over the surface in contact with the brushes.

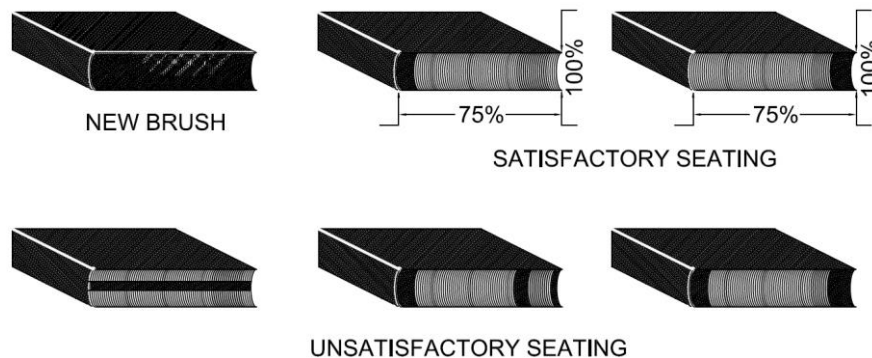


ILLUSTRATION 12



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3.5 FUNCTIONAL TEST: After run-in is complete perform the following tests. Tests must be accomplished in the order stated. All tests must be within the limits stated. Any out of tolerance test is reason to reject motor. Any excessive noise or vibration is reason to stop the test to determine and correct the cause.

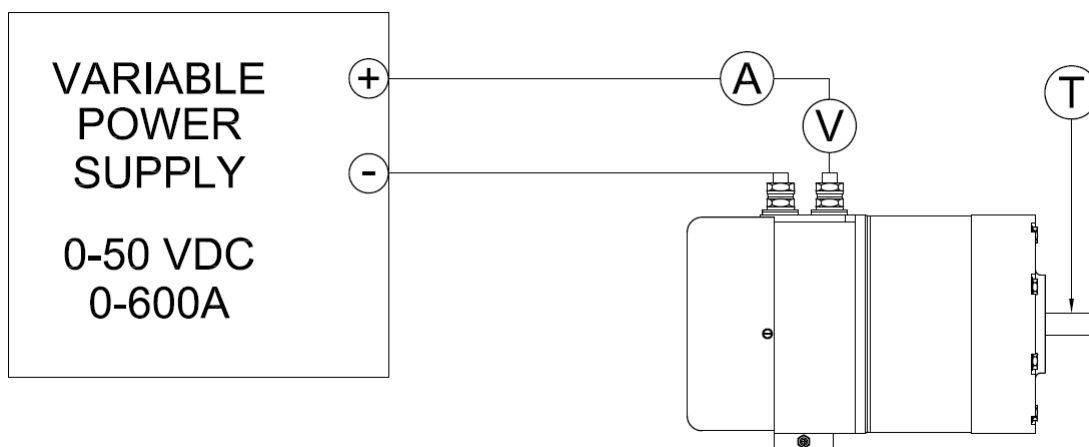
**WARNING**

***THE Z88-800 MOTOR IS A HIGH TORQUE MOTOR. THE MOTOR MUST BE SECURED TO PREVENT ROTATING DURING THESE TESTS. INJURY COULD OCCUR IF THE MOTOR IS NOT SECURED AT START UP.***

**NOTE**

***Supply external cooling to the motor during these tests.***

3.5.1 FREE SPIN – COLD. Set up is shown in ILLUSTRATION 13.



V => Voltmeter  
A => Ammeter  
T => Tachometer

Refer to TABLE 2.3 for Equipment Specifications.

ILLUSTRATION 13

3.5.1.1 Slowly apply voltage. The motor should start to spin before 3 VDC is reached. Note starting voltage.

3.5.1.2 Apply 28 VDC. The stabilized RPM should be a minimum of 8,000. Note the RPM





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3.5.1.3 When unit RPM has stabilized the running current should be less than 35 Amperes. Note the stabilized current.

3.5.2 LOCKED ROTOR. Set up is shown in ILLUSTRATION 14.

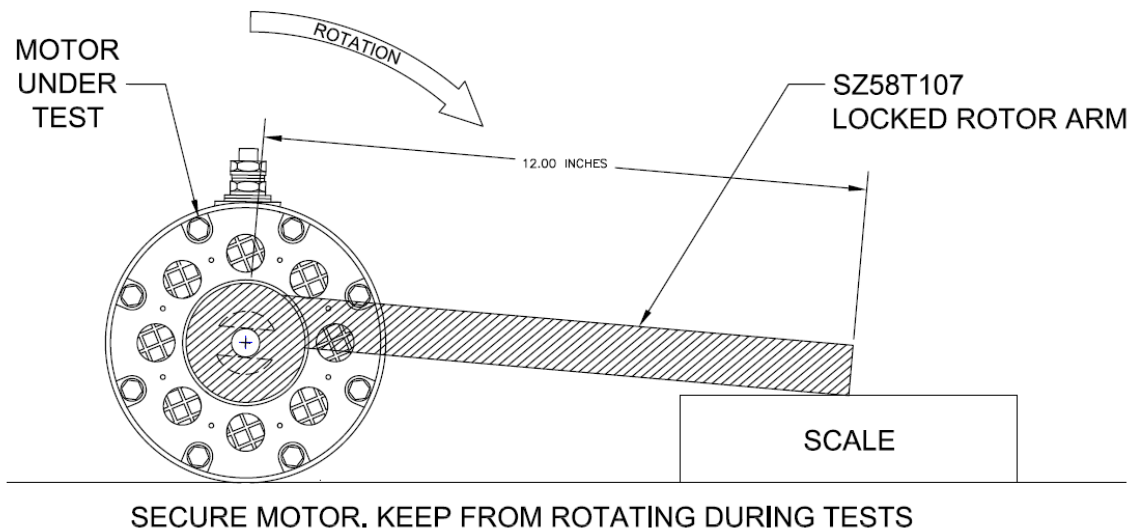


ILLUSTRATION 14

3.5.2.1 Apply 8 VDC. After 3 seconds the current should be less than 525 Amperes. Note the amperes reading. DO NOT maintain test for longer than 6 seconds.

3.5.2.2 Apply voltage 8 VDC until a reading of 4 ft-lbs. torque is achieved. The current should be less than 525 Amperes. Note the amperes reading. DO NOT maintain test for longer than 6 seconds.

3.5.3 FREE SPIN – HOT. Perform these tests with the motor still hot from Test 3.5.2. Remove the SZ58T107 Locked Rotor Arm fixture to allow the motor to spin free.

3.5.3.1 Slowly apply voltage. The motor should start to spin before 3 VDC is reached. Note starting voltage.

3.5.3.2 Apply 28 VDC. The stabilized RPM should be a minimum of 8,000. Note the RPM

3.5.3.3 When unit RPM has stabilized the running current should be less than 35 Amperes. Note the stabilized current.



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**4.0 SERVICE**

4.0.1 The only service required between overhauls is a brush inspection and replacement. Refer to 5.0 for service schedules. If space allows this service may be performed on the aircraft.

4.1 **BRUSH INSPECTION:** REFER to Service Letter SL99-800-2 and SL99-800-4 for more detailed inspection procedures. Brushes may be inspected without removing the motor from the installation. If possible, remove the brush covers to reveal the brushes. If brushes are removed completely from the motor for inspection mark the location and return each brush to its original holder. If the top of the brush is at the top of the brush holder the brushes must be replaced.

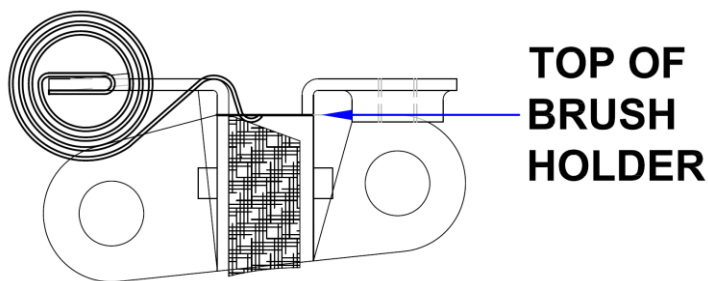
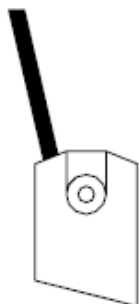


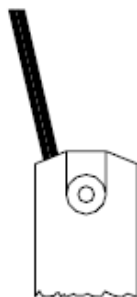
ILLUSTRATION 15

4.1.1 Lift the brush spring off the brush and slide the brush from the holder. The brush should slide easily in and out of the holder. If the brush is tight in the holder or if there is excessive side to side movement of the brush in the holder the motor should be removed for repair or overhaul.

4.1.2 Check each brush for chips, cracks, pitting, signs of arcing or overheating.



IF UNEVEN WEAR  
IS FOUND CHECK  
FOR WEAK SPRING  
TENSION



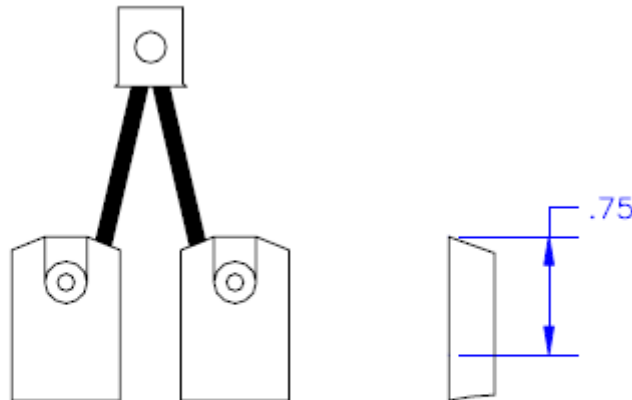
IF GROOVED WEAR IS FOUND  
CHECK FOR UNUSUAL WEAR  
ON COMMUTATOR



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ILLUSTRATION 16



**CARBON CONTACTS DO NOT HAVE  
TO BE THE SAME LENGTH IN A  
BRUSH ASSEMBLY**

ILLUSTRATION 17

4.1.3 With the brushes removed inspect the armature commutator for signs of overheating or unusual wear. A blackened film of carbon on the commutator is normal. Check for deep grooves or other signs of uneven wear on the commutator. Turn the armature by hand and check that there is no binding or end play. If any defect is noted the motor should be removed from service and repaired or overhauled.

4.1.4 When returning brushes to the holder gently lower the brush spring onto each brush. Do not drop the spring onto the top of the brush as damage to the brush may result.

## **5.0 SERVICE SCHEDULES**

### **5.1 INSPECTION**

| <b>ITEM<br/>DESCRIPTION</b> | <b>INSPECTION<br/>INTERVAL - HOURS*</b>         |
|-----------------------------|---|
| Brush                       | Every 500 hours. Inspect and replace as per 4.1 |

### **5.2 OVERHAUL**

| <b>ITEM<br/>DESCRIPTION</b> | <b>R&amp;R/T.B.O.<br/>HRS*</b> |
|-----------------------------|--------------------------------|
| Motor                       | 2,000                          |



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**\* These intervals are the MAXIMUM times. In high corrosive operating environments the Inspection and T.B.O. intervals should be evaluated by the operator because wear will be accelerated. Shorter intervals may be implemented.**

***6.0 TOLERANCES***

| <b>DESCRIPTION</b>            | <b>TOLERANCE</b>   |
|-------------------------------|--|
| Armature, commutator          | Min. OD is 2.125<br><br>Concentricity bar to bar must be within 0.0002in.<br><br>Concentricity with shaft must be within 0.0008in. T.I.R |
| Armature shaft, Drive End     | OD, .5620-5625.  |
| Armature shaft, Comm End      | OD, .6692-.6695.   |
| Fan, bore diameter            | Max. ID is .6715.  |
| Drive End Bell, bearing liner | ID is 1.8500-1.8505.   |
| Comm End, bearing liner       | ID is 1.5747-1.5753.   |
| Brushes                       | Min. .75   |

TABLE 6-1



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**7.0 TROUBLE SHOOTING**

| <b>TROUBLE</b>  | <b>POSSIBLE CAUSE</b>                               | <b>REMEDY</b>                              |
|---|---|--|
| Compressor Motor trips circuit breaker or current limiter | Motor shorted.<br>Motor brushes worn beyond limits. | Repair/Overhaul/<br>Replace Motor.         |
|   | Short in wiring.                                    | Check wiring to motor, repair as required. |
|   | Motor bearing defective.                            | Repair/Overhaul/<br>Replace Motor.         |
| Compressor Motor inoperative.                             | Motor open.<br>Motor brushes worn beyond limits.    | Repair/Overhaul/<br>Replace Motor.         |
|   | Short in wiring.                                    | Check wiring to motor, repair as required. |
|   | System pressure cut out switch open.                | Check switch or system pressure.           |
| Excessive vibration at Motor/Compressor.                  | Improper belt tension.                              | Adjust belt to correct tension.            |
|   | Worn, damaged or loose or over tightened mounts.    | Adjust or replace mounts.                  |
|   | Motor bearing defective.                            | Repair/Overhaul/<br>Replace Motor.         |

TABLE 7-1



## **ZEE Systems, Inc.**

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#### **8.0 ILLUSTRATED PARTS LIST**

##### **8.0.1 EXPLANATION OF SYMBOLS:**

ALT - The Part Number shown is an approved alternate, either part number may be used.

MOD "X" Refers to modification information of this part as applicable to this assembly.

NP - Not Procurable individually, see next higher assembly.

NS - Not Shown

OBS - Obsolete

USAGE/QTY - This identifies parts used on specific applications (not common to all units).

If no code is stated the part is common to all dash numbers.

.. - Part of higher assembly.

\*/# - See explanation at end of parts list.

8.0.2 INTERCHANGEABLE HARDWARE: "AN", "MS", "NAS" and "AS" equivalent hardware is considered to be approved alternates for each other and may be used. The most common are as follows:

| PART NUMBER | ALTERNATE     | DESCRIPTION  |
|-------------|---------------|--------------|
| AN345-516   | MS35650-331   | NUT, MACHINE |
| AN364-624A  | MS21083N6     | LOCK NUT     |
| AN365-428A  | MS21044N4     | LOCK NUT     |
| AN365-832A  | MS21044N08    | LOCK NUT     |
| AN501A10-6  | MS35266-61    | SCREW        |
| AN935-416   | MS35338-44    | WASHER, LOCK |
| AN935-516   | MS35338-45    | WASHER, LOCK |
| AN935-616   | MS35338-46    | WASHER, LOCK |
| AN935-8     | MS35338-42    | WASHER, LOCK |
| AN960-416   | NAS1149F0463P | WASHER, FLAT |
| AN960-416L  | NAS1149F0432P | WASHER, FLAT |
| AN960-516   | NAS1149F0563P | WASHER, FLAT |
| AN960-516L  | NAS1149F0532P | WASHER, FLAT |
| AN960-616   | NAS1149F0663P | WASHER, FLAT |
| AN960-616L  | NAS1149F0632P | WASHER, FLAT |



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#### 8.1 ILLUSTRATED PARTS LIST Z99-800-1.

|                        |                        |                           |                   | <i>USAGE</i>             |
|------------------------|------------------------|---------------------------|-------------------|--------------------------|
| <b><u>FIG-ITEM</u></b> | <b><u>PART No.</u></b> | <b><u>DESCRIPTION</u></b> | <b><u>QTY</u></b> | <b><u>CODE NOTES</u></b> |
| 1                      | Z99-800-1              | Motor, Compressor Drive   |                   | A                        |
| -1                     | SZ37-012-3             | Placard”+”                | 1                 |                          |
| -2                     | SZ37-012-5             | Placard “-“               | 1                 |                          |
| -3                     | SZ38-006-3             | Cover, Fan                | 1                 |                          |
| -4                     | Z99-501-1              | Cover, Fan                | 1                 |                          |
|                        | SZ38-006-3A            | Alternate                 |                   |                          |
|                        | SZ58-504-1             | Alternate                 |                   |                          |
| -5                     | SZ58-004-3D            | Armature                  | 1                 |                          |
|                        | SZ58-004-3             | Alternate                 |                   |                          |
| -6                     | SZ58-008-3             | Brush cover               | 1                 |                          |
| -7                     | SZ58-008-4             | Cover, Brush              | 1                 |                          |
| -8                     | SZ58-020-1             | Drive End Bell, (D.E.)    | 1                 |                          |
|                        | SZ58-005               | Alternate                 |                   |                          |
| -9                     | SZ58-021-1A            | End Bell, Anti-Drive End  | 1                 | Pre-Mod A                |
| -10                    | SZ58-021-1B            | End Bell, Anti-Drive End  | 1                 | Mod A                    |
| -11                    | SZ58-026-1             | Stator                    | 1                 | Pre-Mod F                |
|                        | SZ58-026-2             | Alternate                 |                   |                          |
| -12                    | Z99-401-1              | Fan                       | 1                 |                          |
| -13                    | Z99-840-1              | Bearing                   | 1                 |                          |
| -14                    | Z99-840-3              | Bearing                   | 1                 |                          |
| -15                    | Z6386AK                | Brush Kit                 | 1                 |                          |
| -16                    | JH1163                 | Washer                    | 1                 |                          |
| -17                    | Z99-8545-1             | Retainer                  | 1                 | Mod B                    |
|                        | JH12990-1              | Alternate                 |                   |                          |
| -18                    | Z99-8545-2             | Retainer                  | 1                 |                          |
|                        | JH12989-2              | Alternate                 |                   |                          |
| -19                    | JH12990                | Retainer                  | 1                 |                          |
| -20                    | Z99-8542-1             | Nut, Bearing Lock         | 1                 |                          |
|                        | 05-325003              | Alternate                 |                   |                          |
| -21                    | AN526C1032R10          | Screw                     | 4                 |                          |
|                        | 05-340200              | Alternate                 |                   |                          |
| -22                    | AN502-8-14             | Screw                     | 4                 | Mod B                    |
|                        | 05-349690              | Alternate                 |                   |                          |
| -23                    | Z99-8544-1             | Key                       | 1                 |                          |
|                        | 05-419000              | Alternate                 |                   |                          |
| -24                    | 259179-1               | I.D. Plate                | 1                 |                          |
|                        | 400649-1               | Alternate                 |                   |                          |



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| <i><b>FIG-ITEM</b></i> | <i><b>PART No.</b></i> | <i><b>DESCRIPTION</b></i>    | <i><b>QTY</b></i> | <i><b>USAGE<br/>CODE NOTES</b></i> |
|------------------------|------------------------|------------------------------|-------------------|------------------------------------|
| -25                    | 405690-1               | Placard "Rotation"           | 1                 |                                    |
| -26                    | AN3-15A                | Bolt                         | 8                 |                                    |
| -27                    | AN3-17A                | Bolt                         | 6                 | Pre Mod H                          |
| -28                    | AN316-6R               | Nut                          | 2                 |                                    |
| -29                    | AN4-4A                 | Bolt                         | 1                 |                                    |
| -30                    | MS35266-61             | Screw                        | 4                 |                                    |
|                        | AN501A10-6             | Alternate                    |                   |                                    |
| -31                    | MS35266-65             | Screw                        | 8                 |                                    |
|                        | AN501A10-12            | Alternate                    |                   |                                    |
| -32                    | MS21044N08             | Nut, Lock Alt: AN365-832A    | 1                 |                                    |
| -33                    | MS35206-245            | Screw                        | 1                 |                                    |
| -34                    | MS35206-248            | Screw                        | 4                 |                                    |
| -35                    | MS35338-43             | Washer, Lock Alt: AN935-10L  | 18                |                                    |
|                        | MS35338-43             | Washer, Lock Alt: AN935-10L  | 20                | Mod H                              |
| -36                    | MS35338-44             | Washer, Lock Alt: AN935-416  | 1                 |                                    |
| -37                    | MS35338-46             | Washer, Lock Alt: AN935-616L | 2                 |                                    |
| -38                    | NAS1149F0332P          | Washer, Flat Alt: AN960-10L  | 6                 |                                    |
|                        | NAS1149F0332P          | Washer, Flat Alt: AN960-10L  | 8                 | Mod H                              |
| -39                    | NAS1149F0432P          | Washer, Flat Alt: AN960-416L | 1                 |                                    |
| -40                    | NAS1149F0632P          | Washer, Flat Alt: AN960-616L | 4                 |                                    |
| -41                    | SZ58-806-1             | Armature                     | 1                 | Mod C                              |
| -42                    | 05-325004              | Nut                          | 1                 | Mod C                              |
|                        | Z99-8542-2             | Alternate                    |                   |                                    |
|                        | MS19068-03             | Alternate                    |                   |                                    |
| -43                    | Z99-8543-2             | Washer                       | 1                 | Mod C                              |
|                        | 05-378003              | Alternate                    |                   |                                    |
|                        | MS19070-03             | Alternate                    |                   |                                    |
| -44                    | Z14-300-1              | Brush Band                   | 1                 | Mod D                              |
| -45                    | Z14-300-2              | Brush Band                   | 1                 | Mod D                              |
| -46                    | Z26-032-1              | Thermal Switch Assembly      | 1                 | Mod E                              |
| -47                    | MS35206-226            | Screw                        | 2                 | Mod E                              |
| -48                    | MS35338-41             | Washer, Lock Alt: AN935-6    | 2                 | Mod E                              |
| -49                    | NAS1149FN616P          | Washer, Flat Alt: AN960-6L   | 2                 | Mod E                              |
| -50                    | N3                     | Clamp                        | 1                 | Mod E                              |
| -51                    | SZ58-026-1A            | Stator Assembly              | 1                 | Mod F                              |
| -52                    | Z6386CK                | Brush Kit                    | 1                 | Mod G                              |
| -53                    | SZ58-505-2             | End Bell, Drive              | 1                 | Mod H                              |

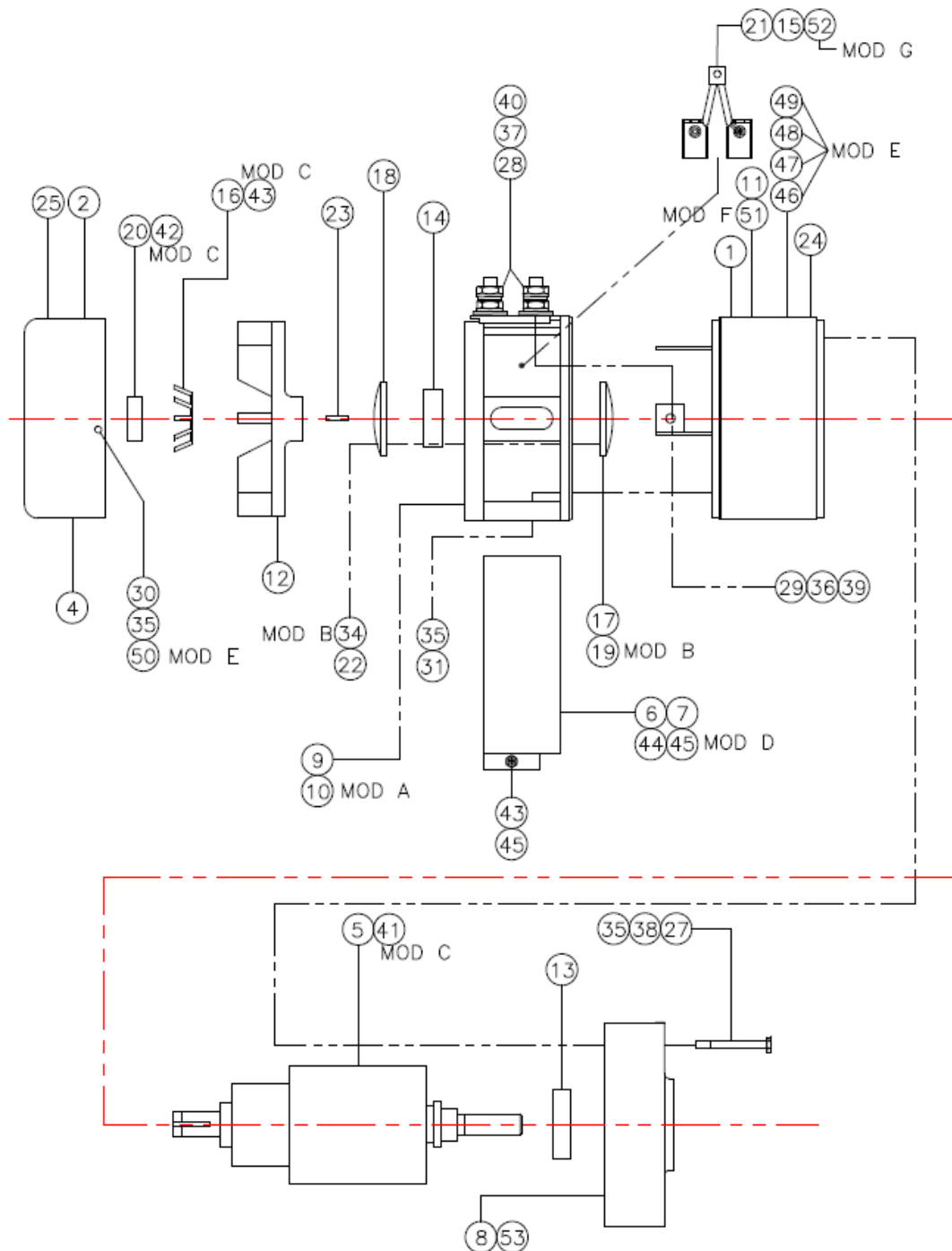
# Mark appropriate Mod on ID Plate.





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**FIGURE 1.**



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8.2 ILLUSTRATED PARTS LIST END BELL ASSEMBLY, COMMUTATOR END SZ58-021. The SZ58-021-1 is not shown. Motors with the SZ58-021-1 must be returned to ZEE Systems, Inc. for rework or replace with the SZ58-021-1A/-1B. FIGURE 2/3/4.

|                 |                 |                             |            | <i>USAGE</i> |              |
|-----------------|-----------------|-----------------------------|------------|--------------|--------------|
| <b>FIG-ITEM</b> | <b>PART No.</b> | <b>DESCRIPTION</b>          | <b>QTY</b> | <b>CODE</b>  | <b>NOTES</b> |
| 2/3/4           | SZ58-021-1A     | End Bell Assy, Comm End     |            | A            |              |
| 2/3/4           | SZ58-021-1B     | End Bell Assy, Comm End     |            | B            |              |
| -1              | SZ58-021-1      | Housing                     | 1          |              |              |
| -2              | Z99-030-1       | Jumper                      | 1          | B            | #3           |
|                 | SZ58-030-1      | Jumper                      | 1          | A            | #3           |
| -3              | SZ58-401-1      | Spacer, Stud                | 1          |              |              |
| -4              | SZ58-007-3A     | Band                        | 1          |              |              |
| -5              | SZ58-500-1      | Holder, Brush               | 4          | B            | #1           |
|                 | SZ58-500-1M     | Holder Brush                | 4          | B            | MOD G #1     |
|                 | JH12922         | Holder, Brush               | 4          | A            | #1           |
| -6              | .. Z99-845-1    | Spring, Brush               | 8          |              | #2           |
|                 | .. JH12539-2    | Alternate                   |            |              |              |
| -7              | MS21045-3       | Nut, Lock Alt: AN365-1032C  | 8          |              |              |
| -8              | 05-374002       | Washer, Insulating          | 8          |              |              |
|                 | JH12519-4       |                             |            |              |              |
| -9              | Z99-8541-1      | Sleeve, Insulating          | 4          |              |              |
|                 | 05-631018       | Alternate                   |            |              |              |
| -10             | 3129            | Washer, Insulating          | 8          |              |              |
|                 | 05-370092       | Alternate                   | 4          |              |              |
| -11             | NAS1149F0332P   | Washer, Flat Alt: AN960-10L | 4          |              |              |
| -12             | MS35266-65      | Screw Alt: AN501A10-12      | 4          |              |              |
| -13             | MS21045-4       | Nut, Lock Alt: AN364-428C   | 4          |              |              |
| -14             | NAS1149F0463P   | Washer, Flat Alt: AN960-416 | 8          |              |              |
| -15             | MS35266-81      | Screw Alt: AN501A416-12     | 4          |              |              |
| -16             | AN316-6R        | Nut                         | 2          |              |              |
| -17             | MS35338-46      | Washer, Lock Alt: AN935-616 | 2          |              |              |
| -18             | NAS1149F0863P   | Washer, Flat Alt: AN960-816 | 3          |              |              |
| -19             | 05-374-041      | Washer, Insulating          | 1          |              |              |
| -20             | Z99-8540-1      | Sleeve, Insulating          | 1          |              |              |
|                 | 05-631023       | Alternate                   |            |              |              |
| -21             | DA10-122        | Terminal Strip              | 1          |              |              |
| -22             | SZ58-503-1      | Stud                        | 2          | A            |              |
|                 | DA10-121M       | Alternate                   | 2          | B            |              |
| -23             | SZ58-501-126    | Insulating Terminal         | 1          | A            |              |
|                 | DA10-126        | Insulating Terminal         | 1          | B            |              |
| -24             | Z99-8540-1      | Sleeve                      | 1          |              |              |
|                 | DA10-129S       | Alternate                   |            |              |              |



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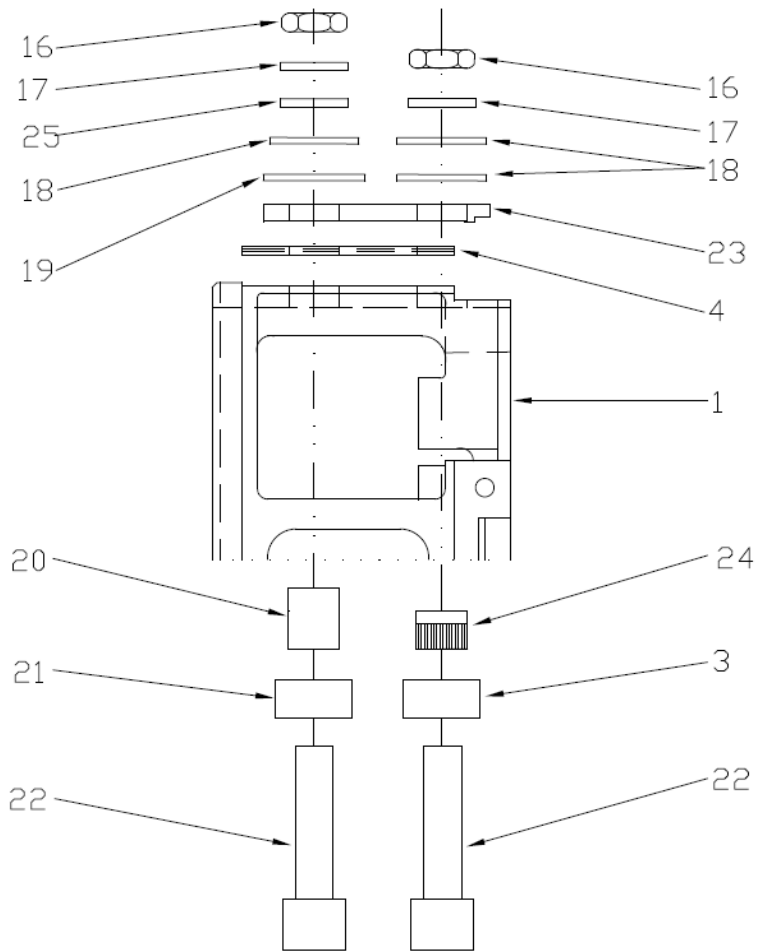
### **COMPONENT MAINTENANCE MANUAL Z99-800**

|     |               |                    |                 |   |
|-----|---------------|--------------------|-----------------|---|
| -25 | NAS1149F0632P | Washer, Flat       | Alt: AN960-616L | 1 |
| -26 | 3129          | Washer, Insulating |                 | 8 |

#1 All 4 Brush Holders must be the same. Either P/N is acceptable.

#2 Brush Spring (2ea) is now included/installed on the SZ58-500-1/-1M when holder is purchased.

#3 Either parts may be used.



VIEW A-A

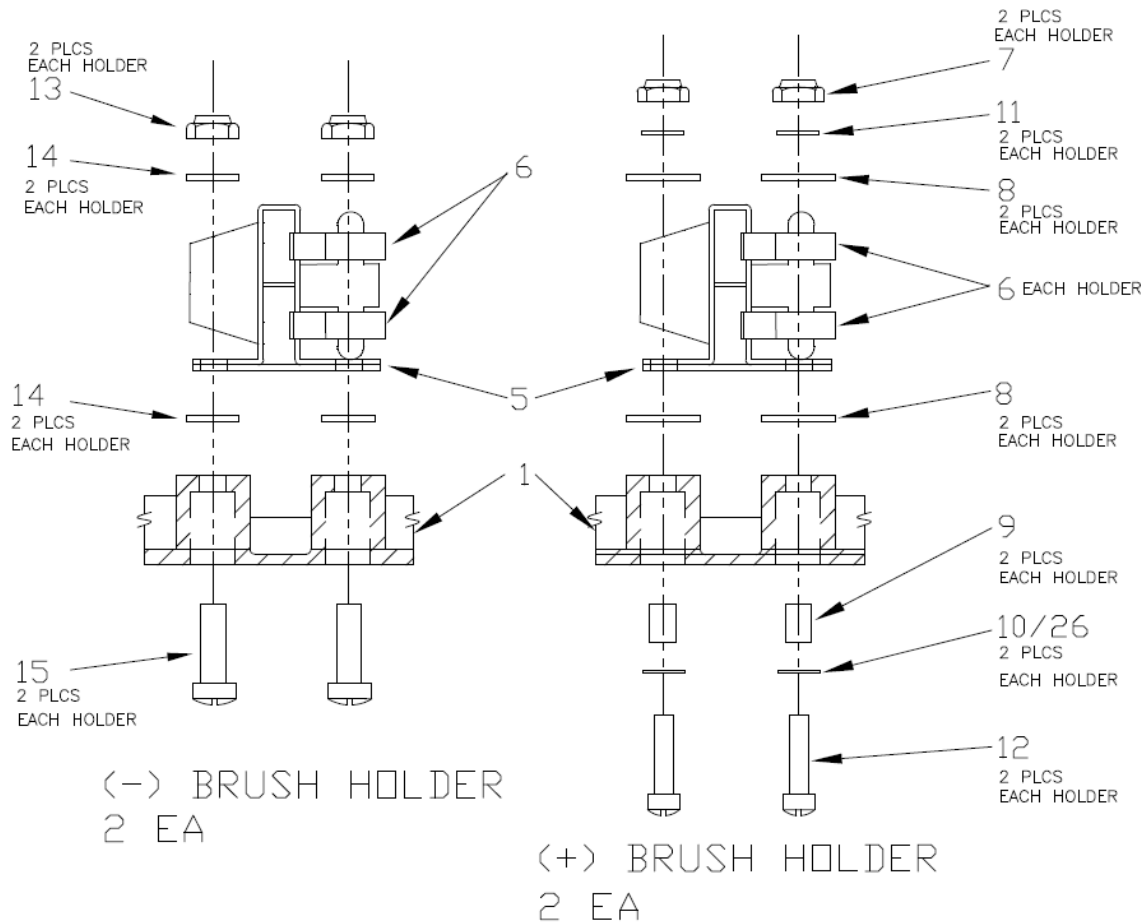
BRUSH HOLDERS OMITTED FOR CLARITY



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**FIG. 2**  
**Commutator End Bell, Terminal Hardware Exploded View.**

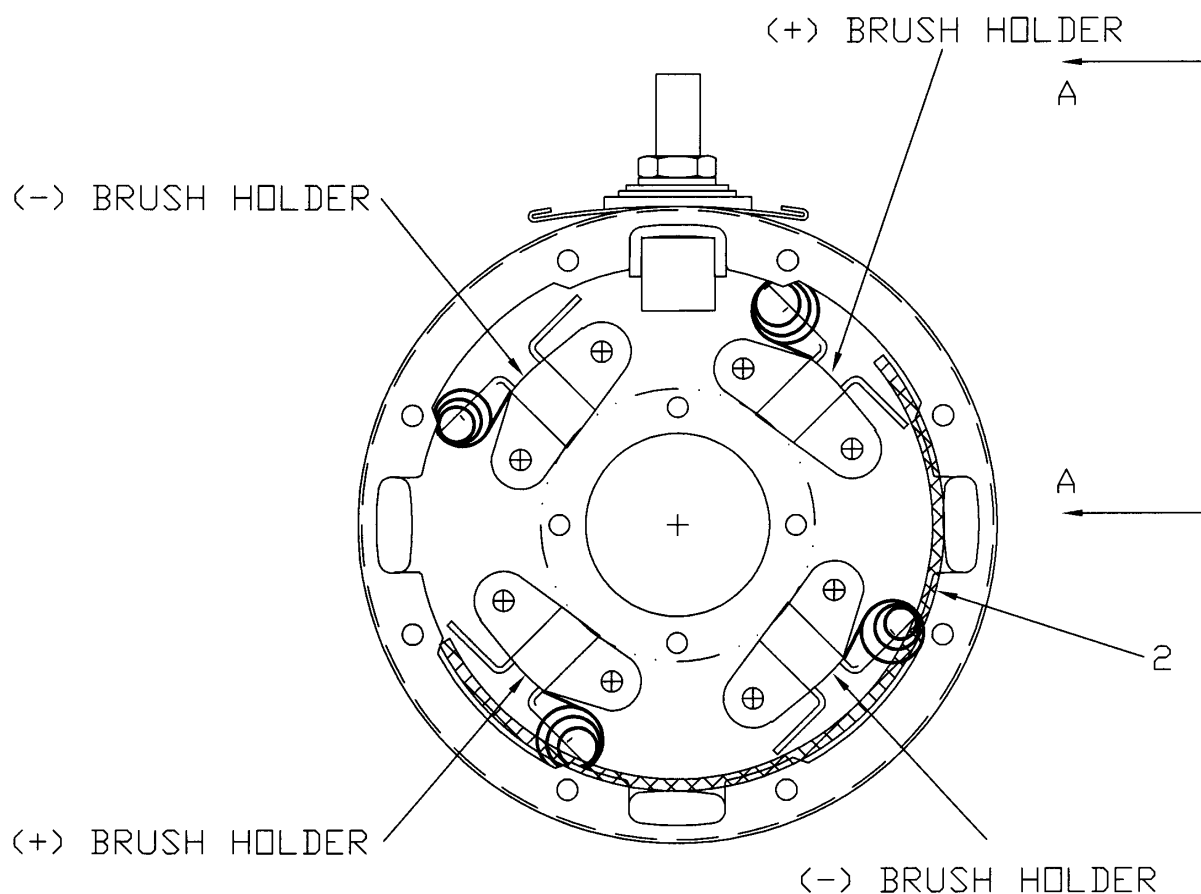


**FIG. 3.**  
**Commutator End Bell, Brush Holder Hardware Exploded View.**



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**FIG. 4.**  
**Commutator End Bell Layout. See Exploded Views for Details**



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***9.0 MODIFICATION SUMMARY***

9.0.1 This section lists modifications to the motor. These modifications are shown on the I. D. Placard.

9.1 MOD "A" Add SZ58-021-1B End Bell assembly to L/M & F/D. SZ58-021-1B is an alternate and interchangeable for SZ58-021-1A.

9.2 MOD "B" Use JH12990-1 Retainer with 4 each MS35206-248 Screw.

9.3 MOD "C" Use 1ea SZ58-806-1 Armature. Attach using 1ea 05-378003 Washer or Alternates Z99-8542-2 or MS19068-03 Washer and 1ea 05-325004 Nut or alternates Z99-8543-2 or MS19070-03 Nut.

9.4 MOD "D" Use Z14-300-1 and Z14-300-2 Brush Bands.

9.5 MOD "E" Attach 1 each Z26-032-1 Thermal Switch to the motor using items 47, 48, 49 and 50.

9.6 MOD "F" Use Stator Assy SZ58-026-1A as alternate for SZ58-026-1.

9.7 Mod "G": Use brush kit Z6386CK. Kit contains 4 each Z6386C Brushes

9.8 MOD "H" Use drive end bell SZ58-505-2 as alternate for SZ58-020-1. 8 each items 35 and 35 are required for this modification.



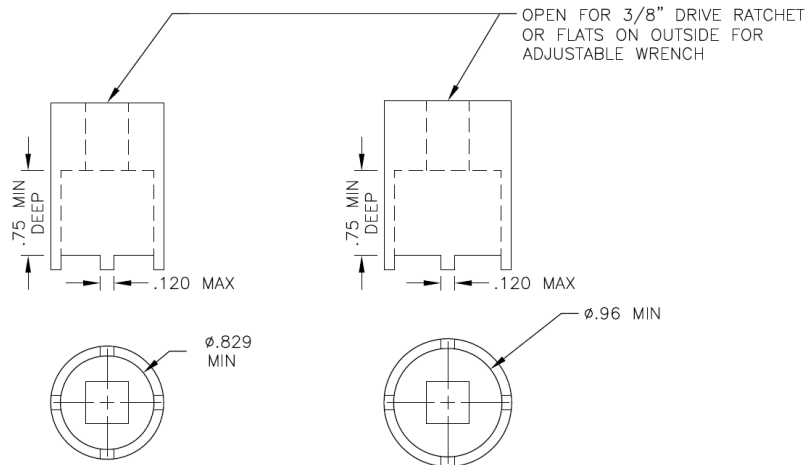
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#### APPENDIX A

This Appendix provides information to fabricate fixtures and tooling needed form the assembly of the SZ58-003 Motor.

Any suitable material may be used. Mild steel or aluminum is recommended.



1. STEEL IS RECOMMENDED FOR THIS TOOL.
2. FABRICATE FROM ROD WITH A SET OF FLATS ON THE OUTSIDE FOR ADJUSTABLE WRENCH.
3. IN PLACE OF ROD A SUITABLE SIZED  $\frac{3}{8}$  DRIVE DEEP SOCKET MAY BE MODIFIED TO MAKE THIS SPANNER.

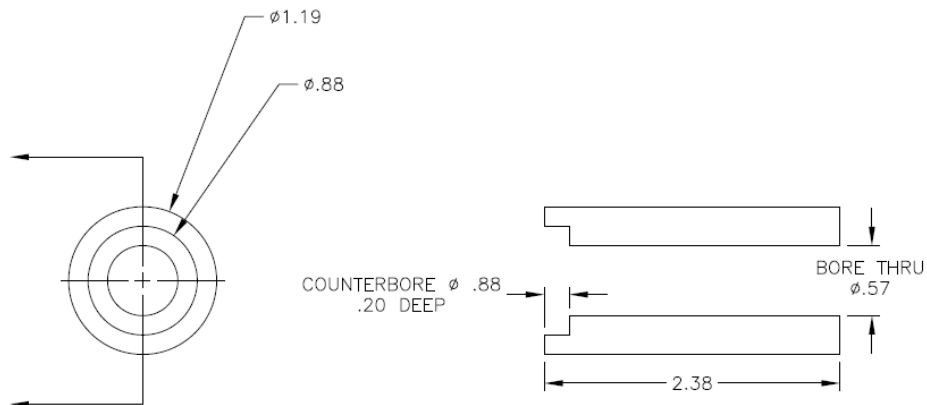
#### SZ58T101-1

Use with Z99-8542-1 Nut

#### SZ58T101-2

Use with Z99-8542-2 Nut (MOD K)

#### SZ58T101A

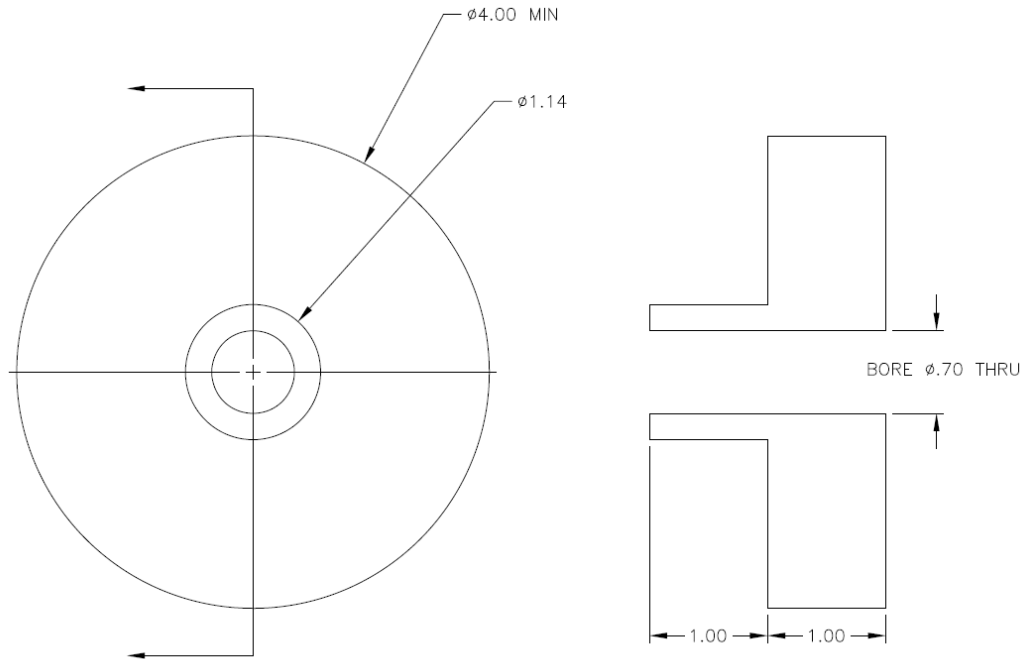


#### SZ58T102

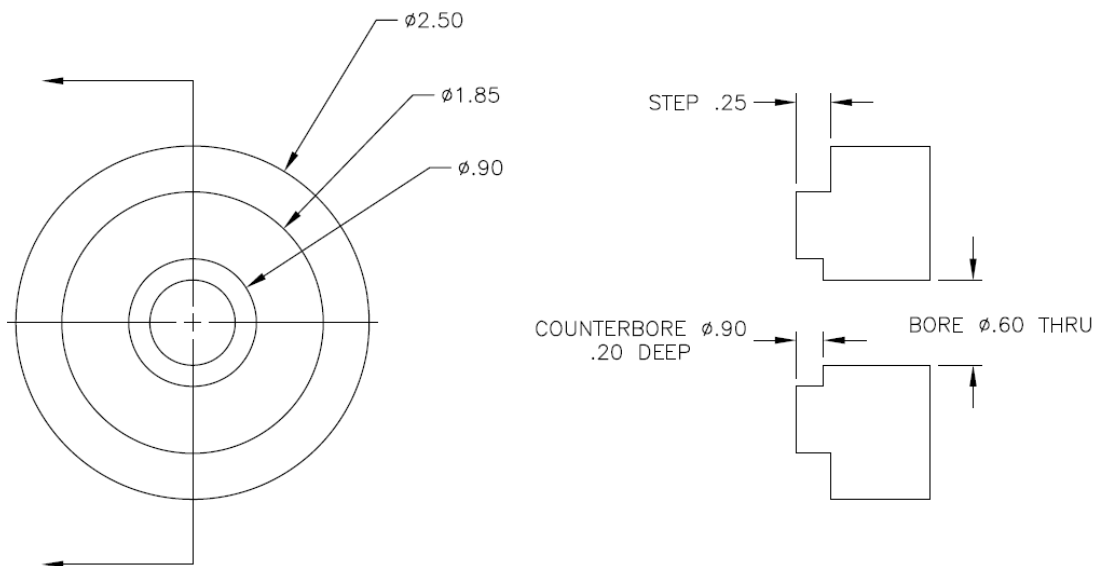


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**SZ58T103**



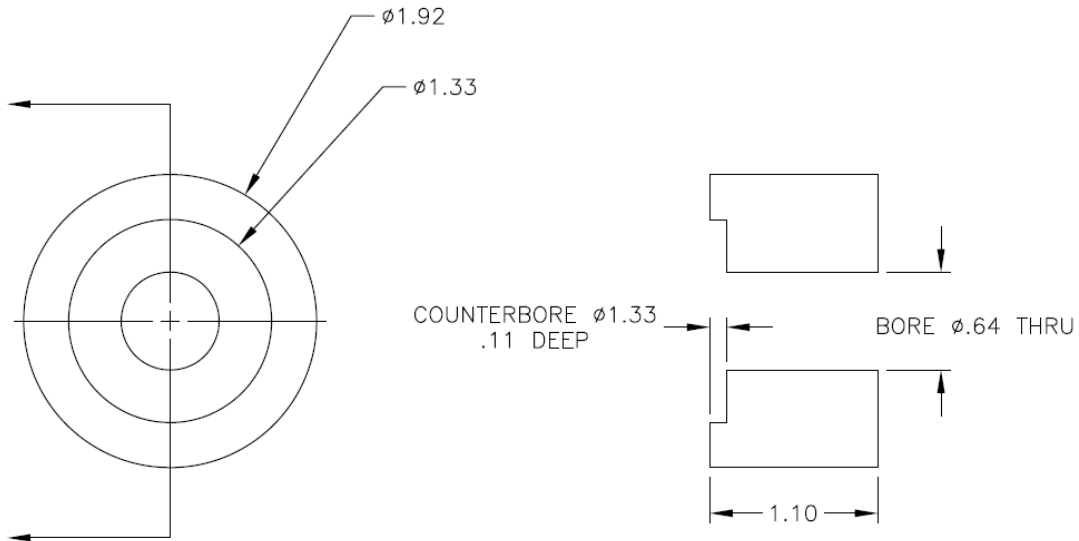
**SZ58T104**



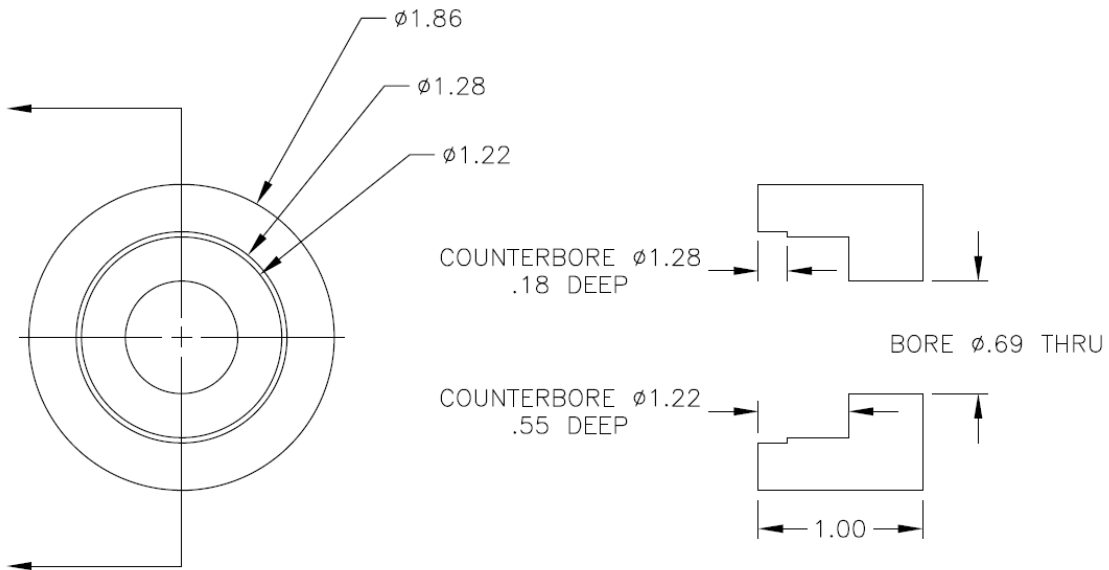


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**SZ58T105**

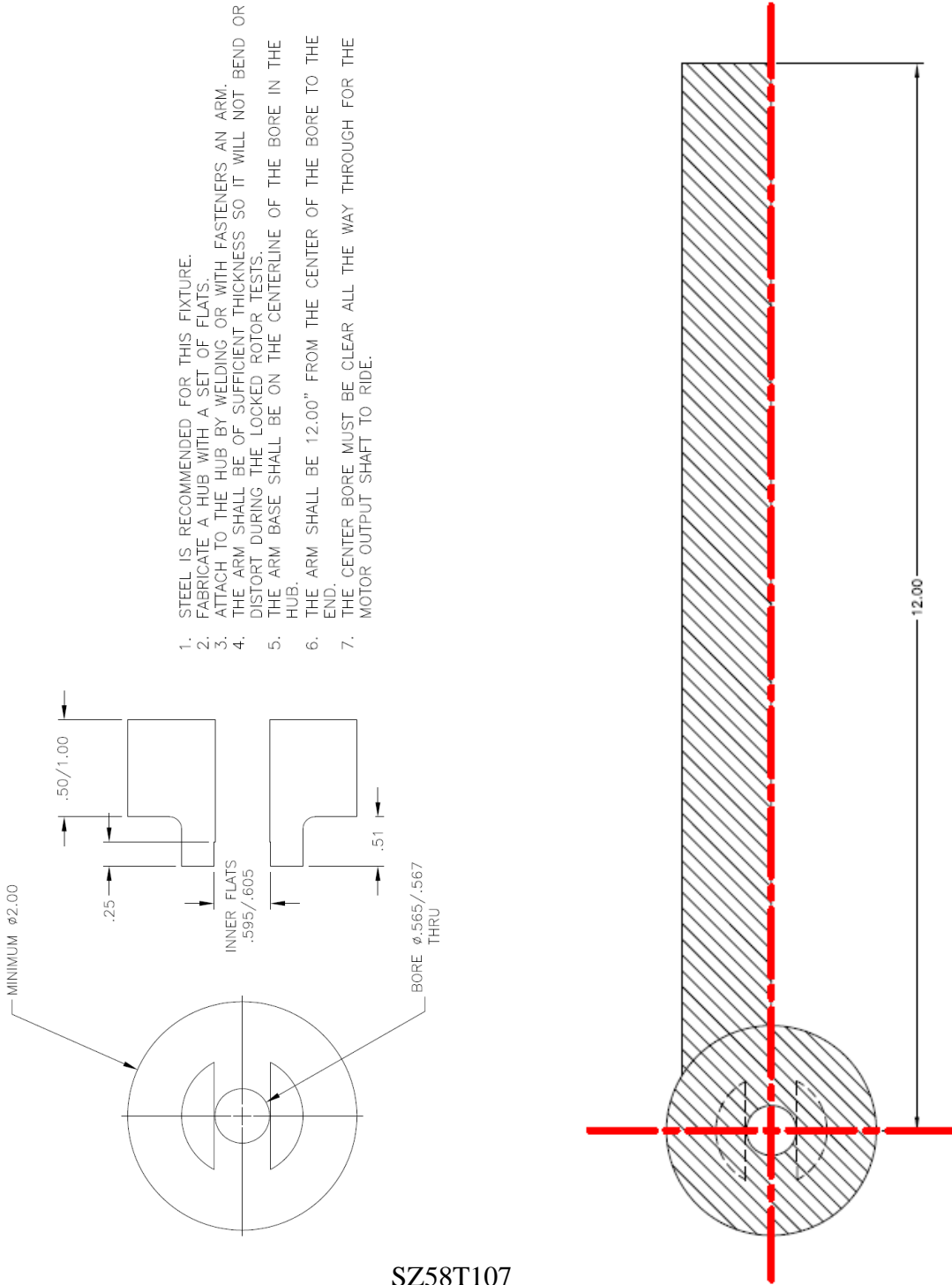


**SZ58T106**



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**SUMMARY OF REVISIONS**

Rev. 1.

1. Update IPL with alternate part numbers.
2. Add or update ILLUSTRATIONS 1 through 13.
3. Add APPENDIX A to manual.

Rev. 2.

1. Add section 3.2.2.3.

Rev. 3.

1. Correct part numbers for IPL FIG.1 Items -42 and -43.

Rev. 4.

1. Correct typos.