Goodrich De-Icing & Specialty Systems
Uniontown, Ohio

Installation and Maintenance Manual
for
Prop De-Icing Systems

ATA 30-60-02

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INTRODUCTION

A. General

1. This manual supersedes Goodrich Reports 68-04-712 and 70-04-700
2. This manual provides installation, maintenance and repair information for Goodrich electrothermal propeller de-icing systems and components installed on general aviation aircraft. Each system and its components are uniquely designed for one application, although operation, installation, maintenance and repair procedures may be common or similar. The Aircraft Manual (AMM) applicable to each aircraft model contains specific information not included in this manual.
3. Information about de-icing systems and/or components not manufactured by Goodrich must be obtained from the component or system approval holder.
4. This manual is intended for use in conjunction with:

   - Applicable Aircraft and/or Prop Manufacturer manuals and instructions
   - Applicable Goodrich General Arrangement Drawing
   - Goodrich ATA 30-60-07 Removal & Installation Manual Electrothermal Prop De-Icers.
   - Goodrich Prop De-Icing Systems Replacement Parts List

5. De-icing system installation, maintenance and repair must comply with FAA Advisory Circular 43 and superseding FAA releases. Safety wiring must be installed in accordance with C.A.R. Part 18 [Ref. C.A.R. 18.30-6(3)] and MS335440.
6. Aircraft and/or prop manufacturers may modify a Goodrich de-icing system, making the instructions in this manual incomplete or not applicable.
7. For technical assistance call 1-800-334-2377 (United States, Canada and Puerto Rico) or 330-374-3743/3706/2139 (other locations), or fax 330-374-2290.
8. Definitions

Approval Holder	aircraft or prop manufacturer or modification house that holds a Type Certificate or Supplemental Type Certificate for the prop de-icing system on a particular prop or aircraft.
Brush Assembly	modular brush assembly or brush block assembly, except as specifically distinguished. In this manual illustrations may depict either brush block assemblies or modular brush assemblies, but are valid for both.
Drawing	applicable Goodrich General Arrangement Drawing.
Long lead de-icer	a de-icer without a separate de-icer wire harness
Optional	component or procedure is not applicable to all de-icing systems.
Slip Ring	slip ring assembly or slip ring/starter ring gear assembly, except as specifically distinguished.

9. Abbreviations

AM = Aircraft Manufacturer
AMM = Aircraft Maintenance Manual
PM = Propeller Manufacturer
PMM = Propeller Manufacturer's Manual
Prop = propeller or propeller assembly

SECTION I
DESCRIPTION AND OPERATION
PROP DE-ICING COMPONENTS AND SYSTEM

A. Prop De-Icing System Components

1. A prop de-icing system consists of the components shown in **Figure 1, this page**. Quantity depends on application.

1. De-Icer
2. Slip Ring
3. Brush Assembly
4. Timer
5. Ammeter (optional)
6. Shunt (optional)
7. Switch (or Circuit) Breaker Switch)
8. Wiring
9. Circuit Breaker (optional)
10. Aircraft Power Source

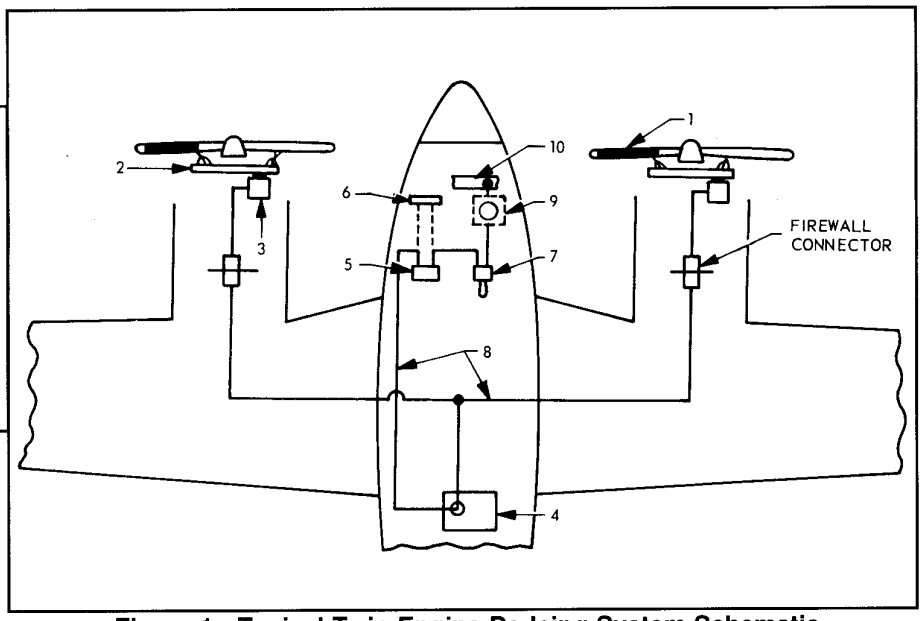


Figure 1 - Typical Twin Engine De-Icing System Schematic

2. Propeller De-Icing System Component Operation

a. A prop de-icer is electrically heated, manufactured with special wire or foil, protected by fabric and rubber plies that resist oil, erosion and abrasion. One side has a dull, fabric-impressioned finish to provide good bonding surface.

b. A wire harness may be used to electrically connect components. For example, a de-icer wire harness may connect de-icer leads to slip ring assembly leads.

c. A slip ring and a brush assembly conduct electric power to the de-icers. The brush assembly, typically mounted on the engine, contains spring loaded brushes that contact rotating copper rings on the slip ring.

d. A timer distributes power to the system in timed intervals in specific sequence.

e. An ammeter is used to indicate system current flow. The ammeter has an internal or external shunt.

f. A switch or circuit breaker/switch is used to cut power in case of overload. Some systems include an extra circuit breaker between system and power supply.

g. Some systems include additional components. Check AMM for complete system information.

B. Propeller De-Icing System Operation

1. Electrically heated prop de-icers, combined with the centrifugal force of the rotating prop and airstream blast, remove accumulated ice. To conserve power and effectively remove ice, de-icers are heated in timed intervals in specific sequence.
2. Propeller de-icing systems differ in three areas:

Number of engines:	Single, twin, multiple
De-icer heating elements:	Single element has two leads (power & ground) Dual element has three leads (inboard, outboard & ground)
Slip ring type:	Slip ring or slip ring/starter ring gear

3. When the system is activated, power is cycled to the de-icers in timed intervals in specific sequence critical to effective ice removal. Sequence depends on number of de-icer elements and engines.

Note: Typical heating interval is 34 seconds. Check AMM to confirm interval for your system. The cycle may begin at any Phase, but the sequence remains the same.

a. Dual element de-icer heating sequence, single engine aircraft:

Phase 1: All outboard de-icer elements for specified interval
Phase 2: All inboard de-icer elements for specified interval

b. Dual element de-icer aircraft heating sequence, twin engine aircraft: **(Figure 2, page 3)**

Note: Some twin engine aircraft have two independent timers that cycle power to de-icers on each prop separately as if there are two single engine systems.

Note: The cycle may begin at any Phase, but the sequence remains the same.

Phase 1: All outboard elements on 1st prop for specified interval
Phase 2: All inboard elements on 1st prop for specified interval
Phase 3: All outboard elements on 2nd prop for specified interval
Phase 4: All inboard elements on 2nd prop for specified interval

c. Single element de-icer heating sequence, single engine aircraft:

Phase 1: All de-icers on for 90 seconds.
Phase 2: All de-icers off for 90 seconds.

d. Single element de-icer heating sequent, twin engine aircraft: **(Figure 3, page 4)**

Phase 1: All de-icers on first prop heated for 90 seconds
Phase 2: All de-icers on second prop heated for 90 seconds

e. Check AMM for sequence on aircraft with three or more engines.

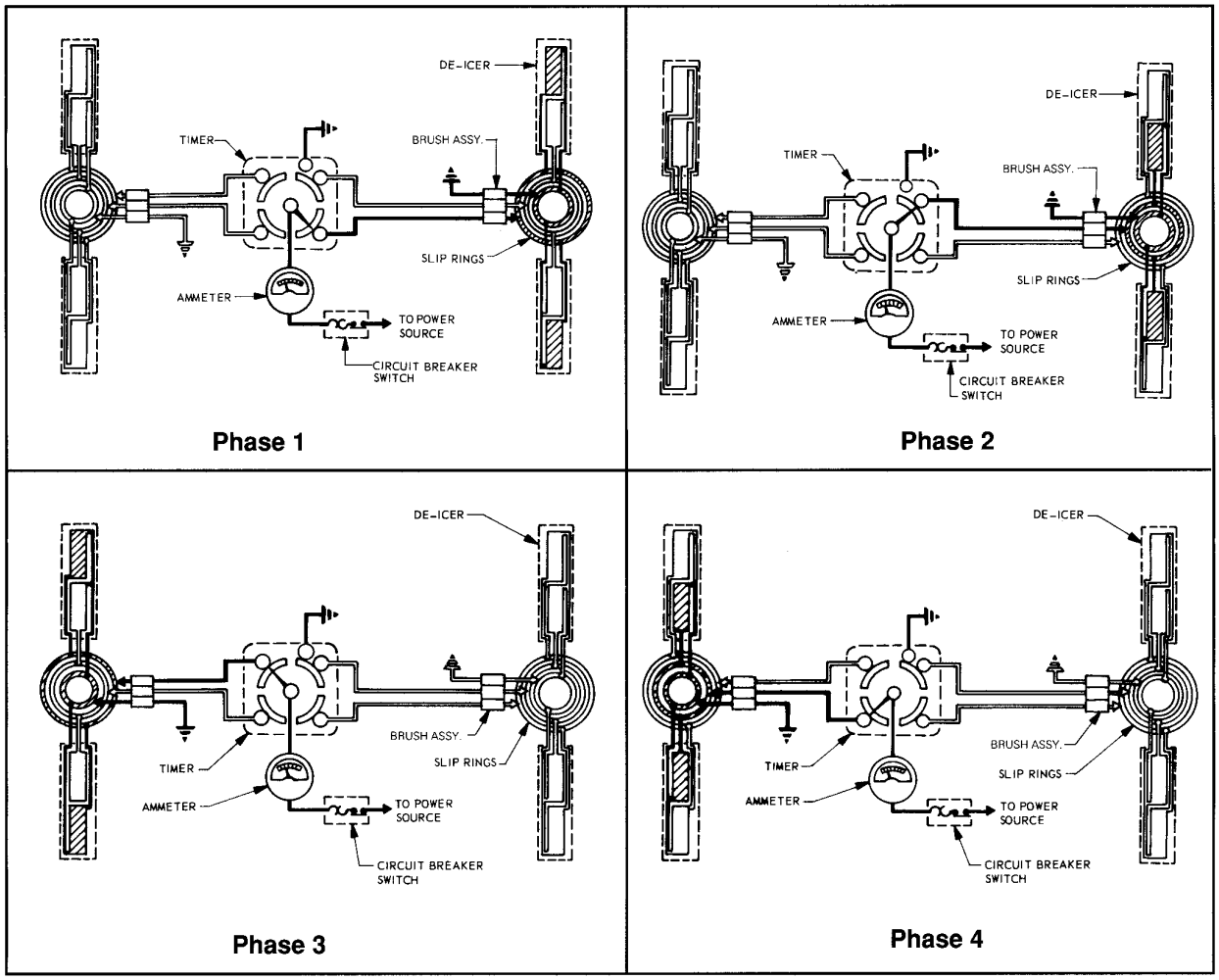


Figure 2 – Dual Element Twin Engine De-Icing Cycle

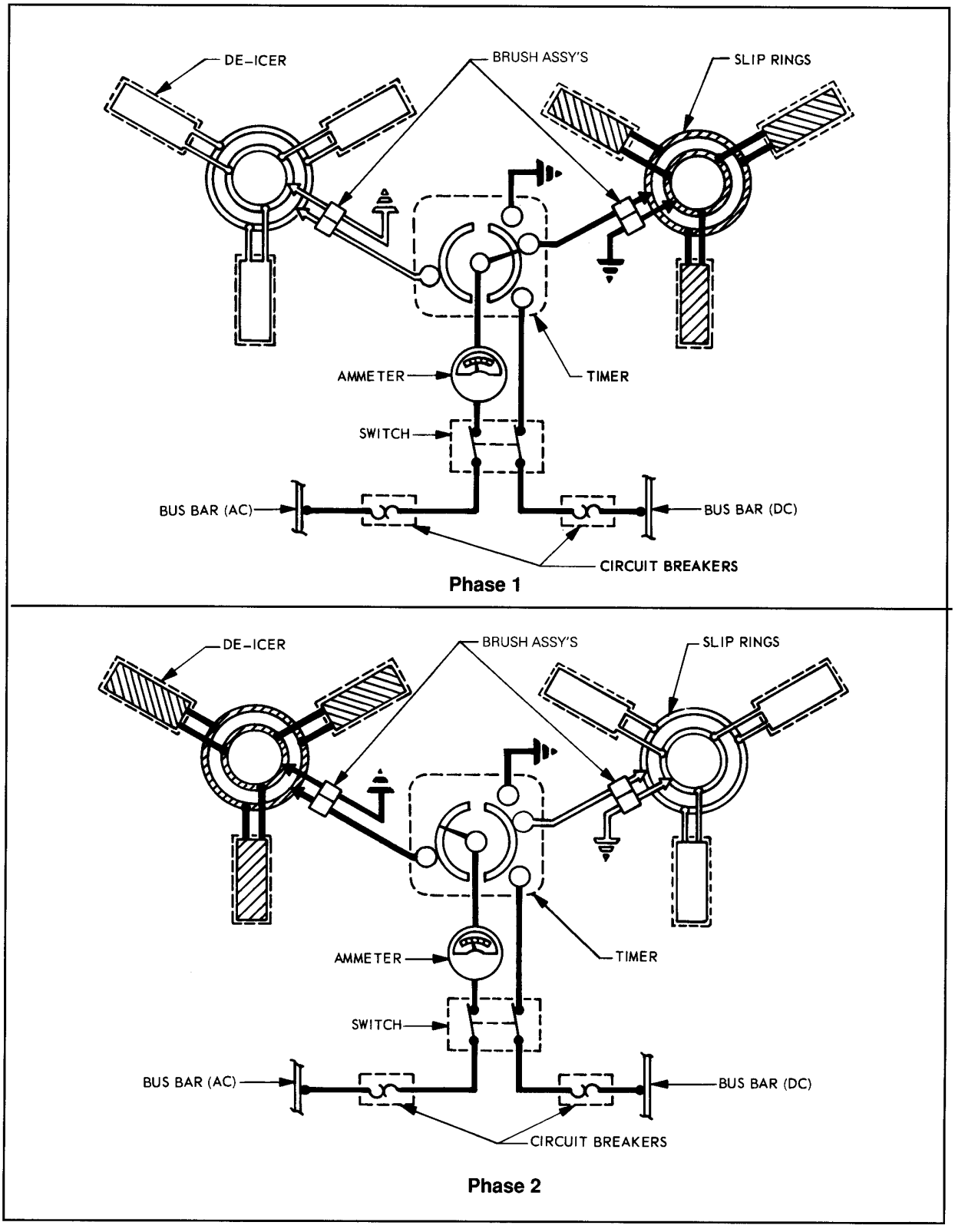


Figure 3 – Single Element Twin Engine De-Icing Cycle

SECTION II
INSTALLATION OF PROP SYSTEM COMPONENTS

Note: Read instructions entirely before proceeding, and follow in order provided.

A. General

1. Information provided is for initial system installation. Some procedures are not applicable for replacement components or conversion kits. Refer to applicable manual for replacement or conversion.
2. A de-icing system can be installed only on aircraft with sufficient electrical capacity for continuous prop de-icing system operation. Check AMM for required amperage, or perform electrical load analysis in accordance with FAA Advisory Circular 43.13-1, Chapter 11, Section 2 and superseding FAA releases, to determine if sufficient power is available.
3. De-icing system installation affects weight and balance of prop. Consult AMM or PMM for specific weight and balance information or calculate before proceeding.
4. General information about component modification/removal necessary to install de-icing system components is provided. Check AMM for specific detail.

CAUTION: Disconnect aircraft battery before proceeding.

B. Removal of Aircraft Components

1. Remove prop, and feather, if applicable, per PMM.
2. Remove starter ring gear on aircraft so equipped; it will be replaced with slip ring/starter gear assembly.
3. Remove engine cowling, nacelle cover, shroud, fairing, fuselage/interior panel as required.

C. Modification of Aircraft Components

1. Spinner bulkhead must be modified on aircraft so equipped. Using dimensions provided in AMM, lay out and drill required holes in spinner bulkhead. Lay out holes on a parallel plane to the spinner bulkhead plane of rotation, and drill perpendicular wire feed-through holes. Drill other holes perpendicular to bulkhead surface, unless otherwise specified in AMM. Maintain tolerances of +/- .005” on decimals and +/- 1/2° on radial locations when laying out and drilling holes on spinner bulkhead. In systems using a slip ring/starter ring gear assembly, the spinner adapter ring may require modification. **(Paragraph L3, Section II, page 27)**
2. It may be necessary to modify spinner dome by removal of material for clearance, and add rubber restrainer straps to protect de-icer leads. Check AMM for applicability and instructions. Refer to Goodrich ATA 30-60-07 for rubber restrainer strap installation instructions. Engine cowling, shroud and baffle may require cut-outs for brush assembly installation. Check AMM for possible modification of other components.

D. De-Icer Installation

1. Install de-icers per Goodrich ATA 30-60-07. Refer to AMM or PMM, drawing or Goodrich Prop RPL for location dimension.
2. De-Icer Installation on Hartzell Compact Prop
   a. Drill 9/32” diameter hole in counterweight and chamfer per **Figure 4, page 6.** File sharp corners and apply zinc chromate paint to area.
   b. Install de-icers per Goodrich ATA 30-60-07. Slide 5/8” transflex tubing over de-icer leads. Insert de-icer wire harness through counterweight. Connect de-icer and wire harness leads, using window splice terminals (AMP 320559 or equivalent). Connect matching leads – GND to GND, etc.

c. Form wires and install MS3367-1-0 tie strap in figure eight configuration as shown in **Figure 5, this page**. Tighten tie strap and slide tubing over coiled wires. Install MS3367-2-0 tie straps loosely around counterweight and wire harness ¼" in from ends of tubing and assure position of tie strap buckles per **Figure 6, this page & Figure 7, page 7.**

d. Install .263 transflex tubing over de-icer wire harness up to counterweight then route under first tie strap per **Figure 6, this page**. Tighten both tie straps. Install terminals (AMP 32442 or equivalent) on wire harness.

Hartzell Compact Propeller

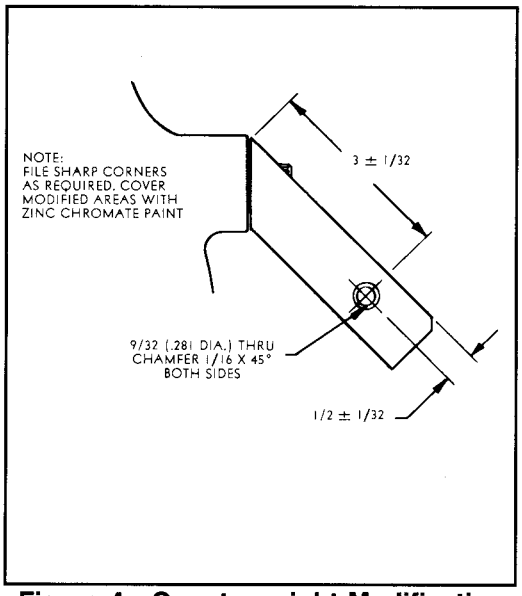


Figure 4 - Counterweight Modification

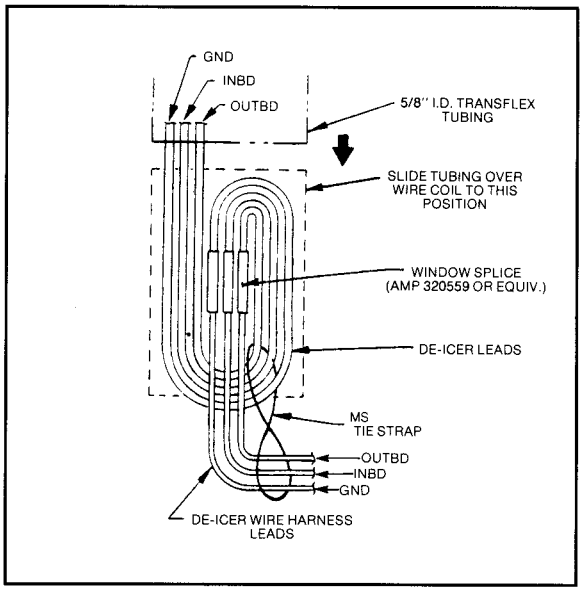


Figure 5 - Lead Configuration

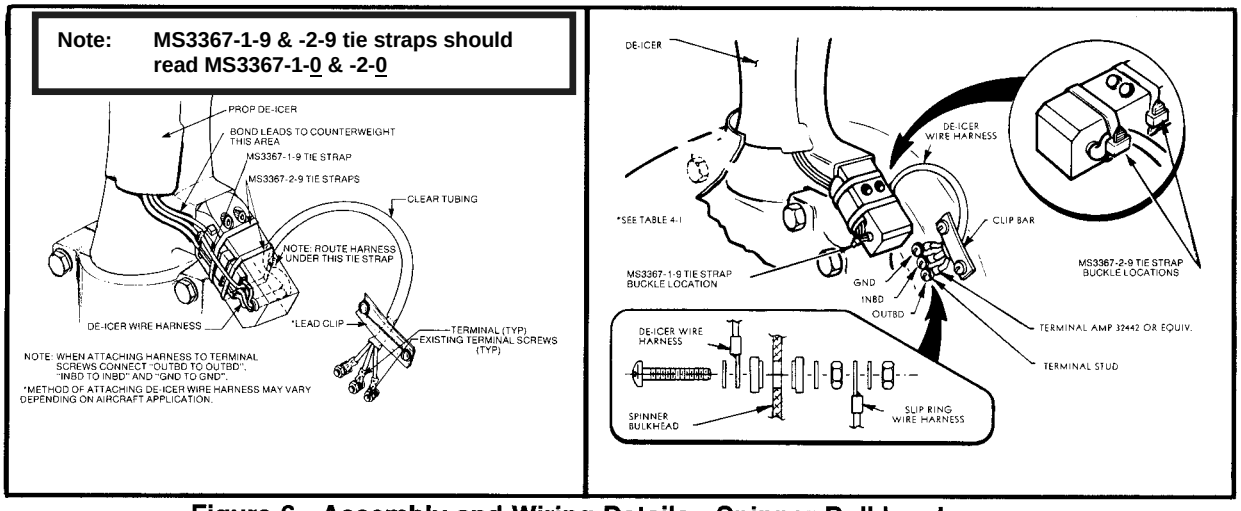


Figure 6 - Assembly and Wiring Details - Spinner Bulkhead

Hartzell Compact Propeller (continued)

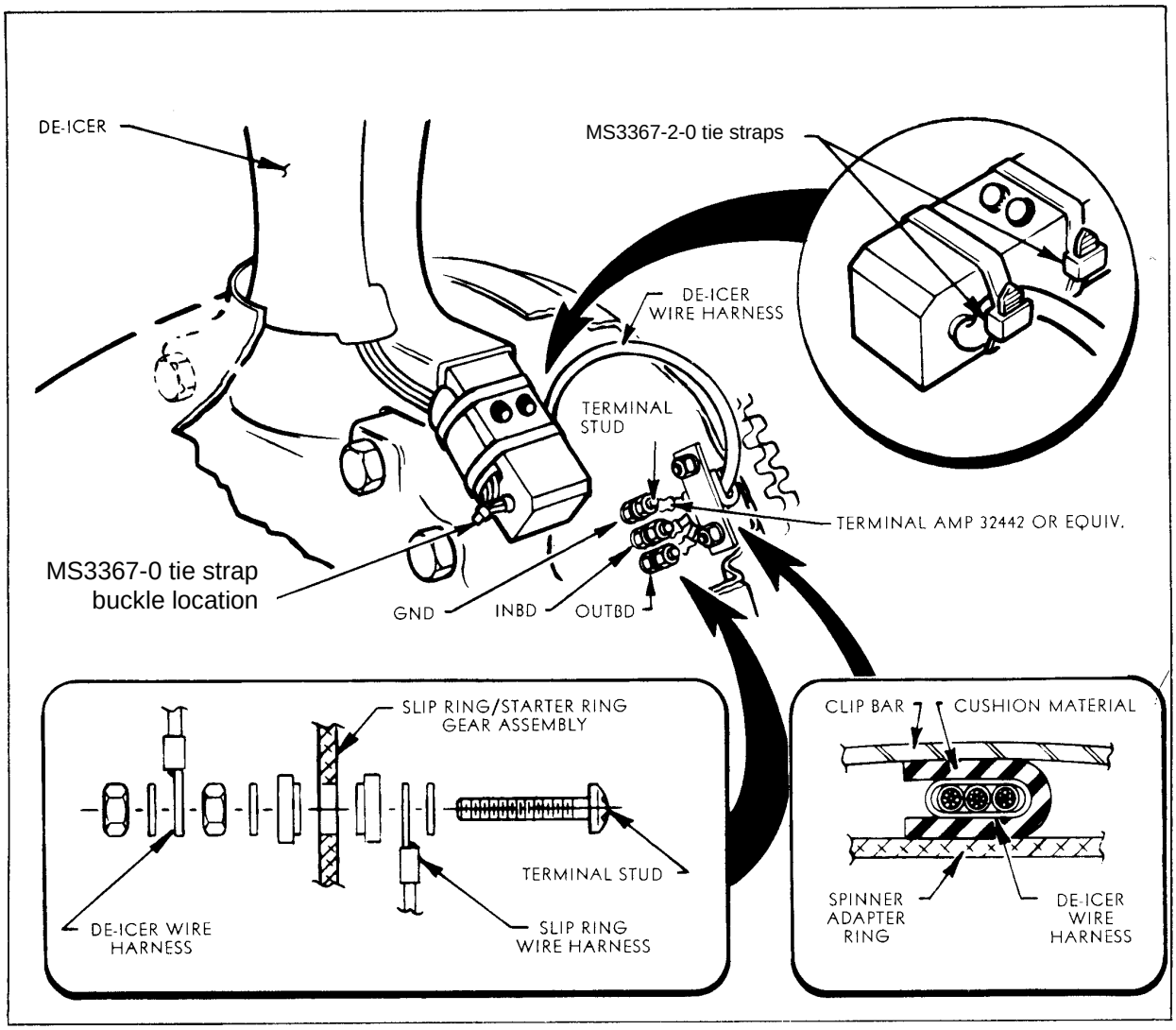


Figure 7 - Assembly and Wiring Details - Slip Ring/Starter Ring Gear Assembly

E. Installation of Balance Weights

1. Record number, type and location of balance weights installed on hub. Remove and save weights and attaching parts. If balance weights are required over or under lead strap clamp, use AN960 washers for shims, trimmed to fit.
2. It may be necessary to modify existing or install new balance weights to avoid interference with de-icer leads. Follow PMM for maximum number of balance weights, and check AMM for modification instructions.
3. If mounting positions of balance weight and lead strap clamp coincide **(Figure 8, page 8 & Figure 12, page 10),** use longer screws for the extra thickness. Make sure there is thread engagement of 2-3 threads beyond nut and that screws do not bottom out or contact spinner dome in any pitch position.

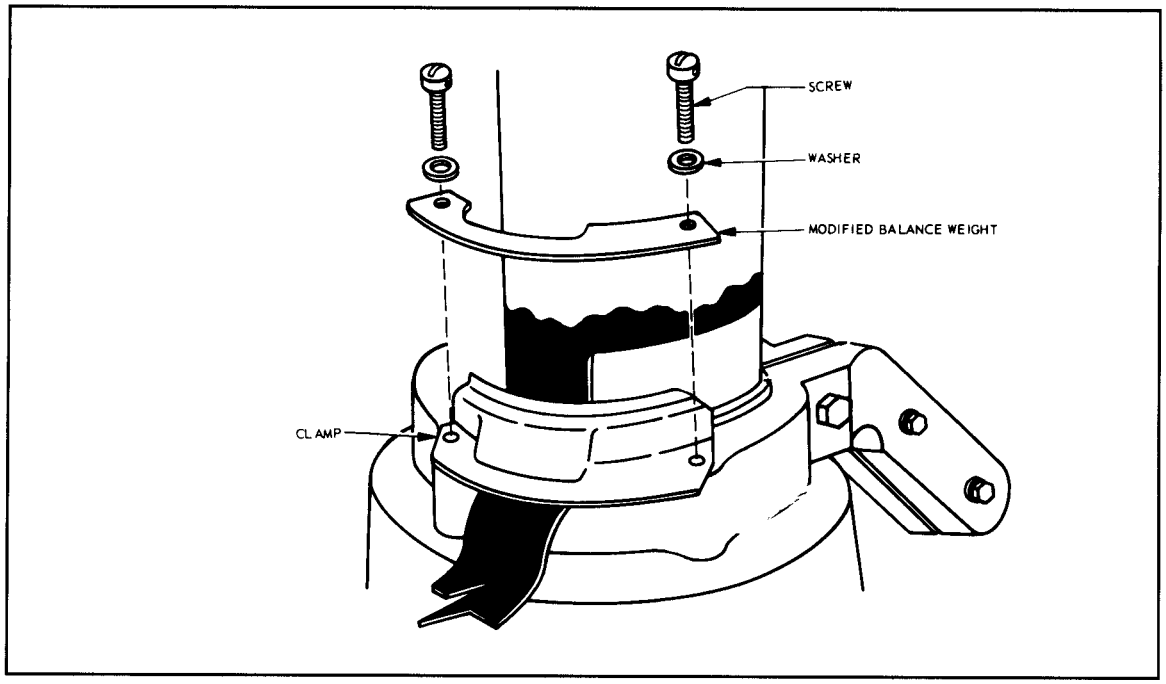


Figure 8 - Modified Balance Weight/Lead Strap Clamp (P/N 4E1725) Installation

F. Installation of Lead Strap Clamps or Restrainers

CAUTION: Lead strap clamp must not squeeze leads tightly enough to cause damage, or enough tension to pull the de-icer loose. Excessive twisting of leads can result in broken wires.

A clamp or restrainer is required at the inboard end of a long lead de-icer to prevent loosening of de-icer by centrifugal force on the lead strap. Typical clamp and restrainer arrangements are shown in **Figures 8-18, pages 8-14**. Use hardware provided in installation kit to attach clamp or restrainer through existing holes in hub. Secure de-icer or wire harness leads to clamp as shown in AMM or drawing.

G. Installation of Rubber Restrainer Straps

Rubber restrainer straps on a single prop must be located equidistant from hub to maintain prop balance **(Figure 13, page 10 & Figure 18, page 14)**. Check AMM, PMM or drawing for correct dimension.

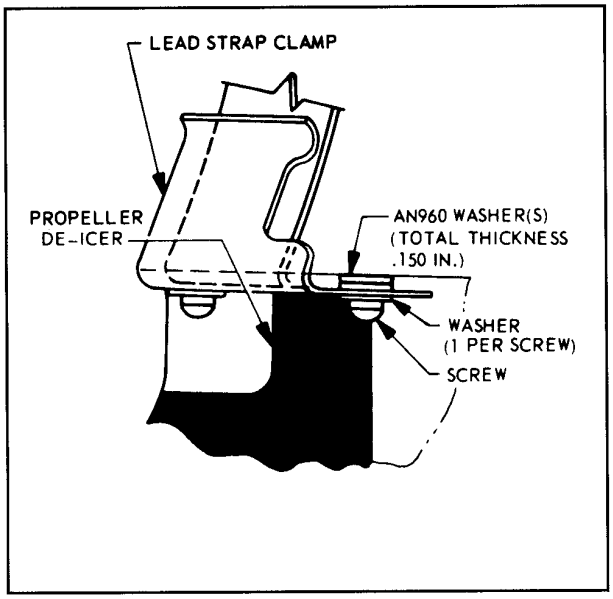


Figure 9 - Lead Strap Clamp (P/N 2E1063-4) Installation

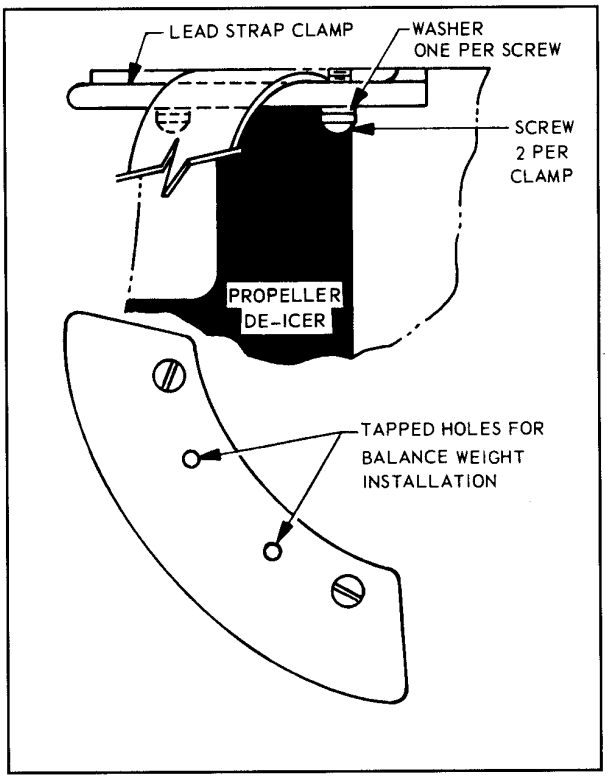


Figure 10 - Lead Strap Clamp (P/N 2E1200-4) Installation

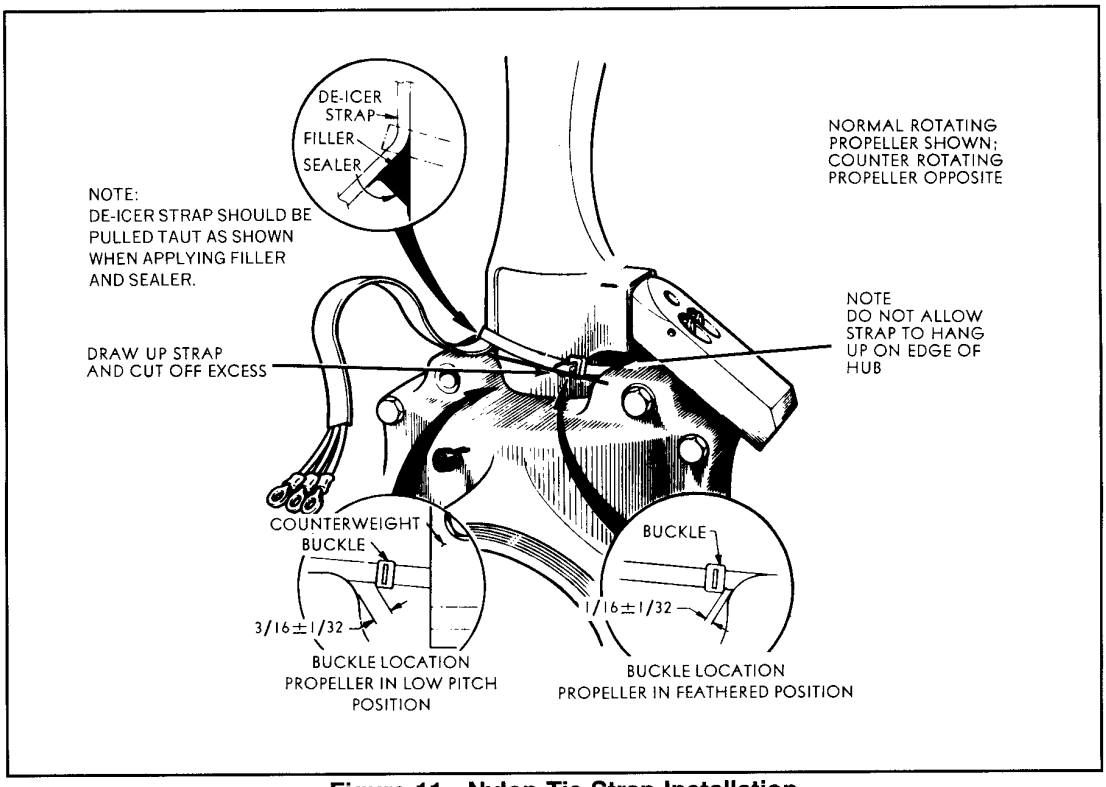


Figure 11 - Nylon Tie Strap Installation

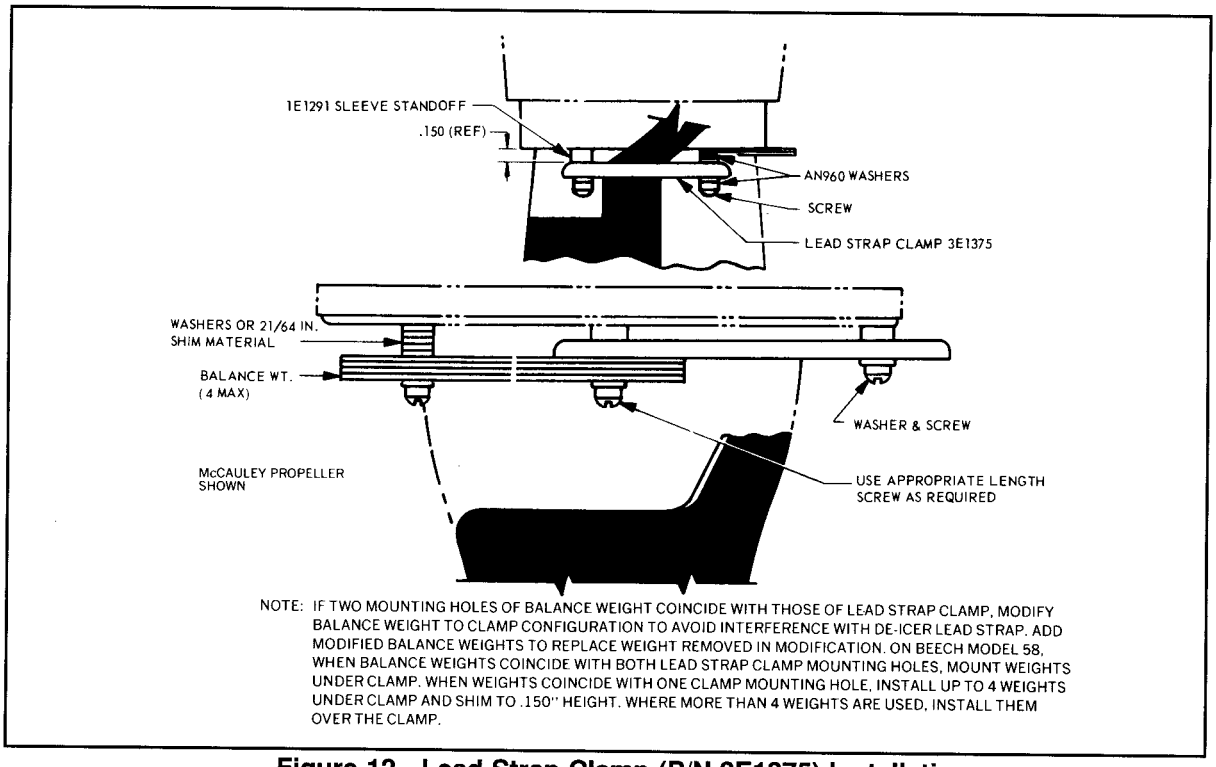


Figure 12 - Lead Strap Clamp (P/N 3E1375) Installation

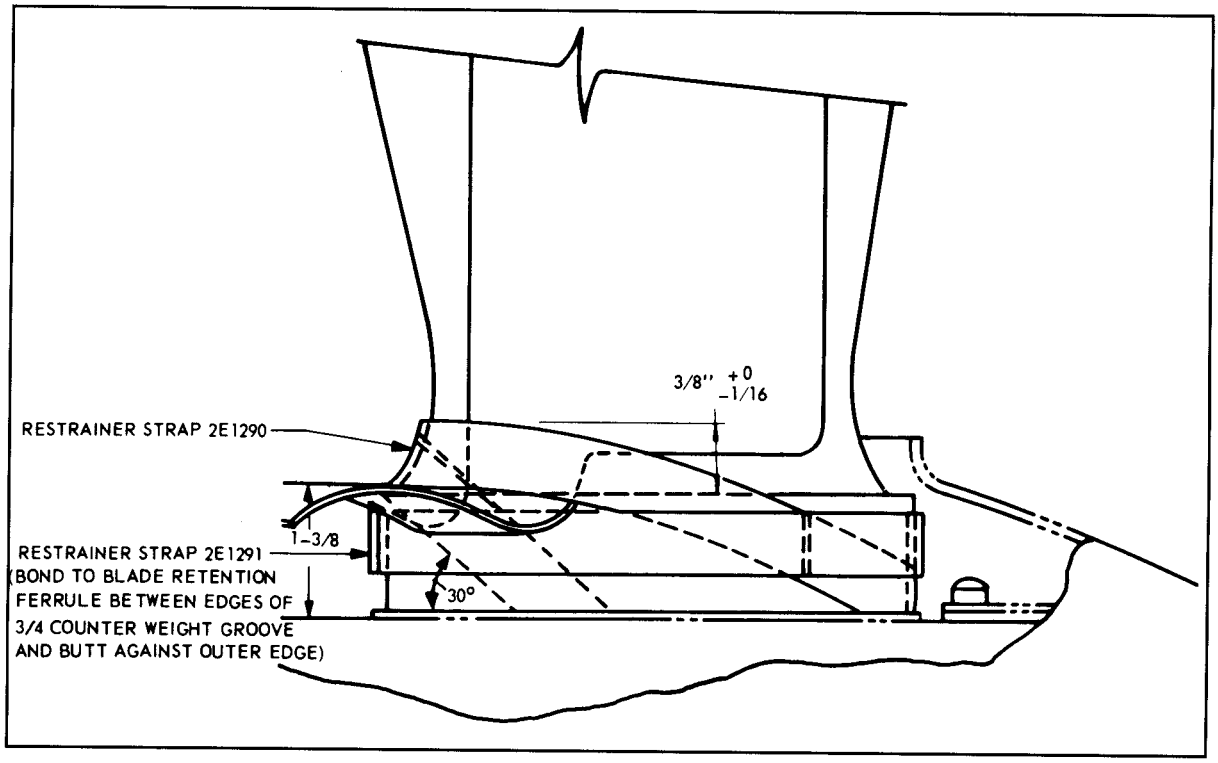


Figure 13 - Restrainer Strap (P/N 2E1290/2E1291) Installation

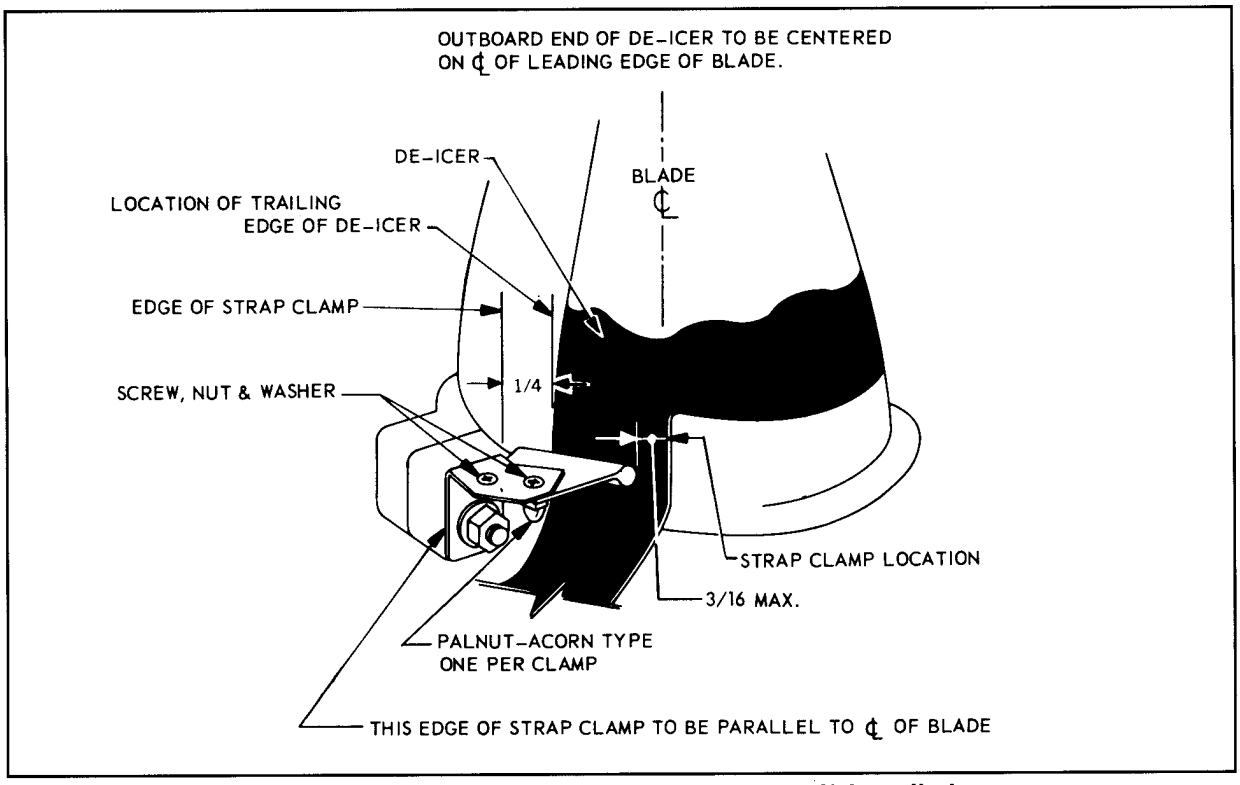


Figure 14 - Lead Strap Clamp (P/N 2E1285-1,-2) Installation

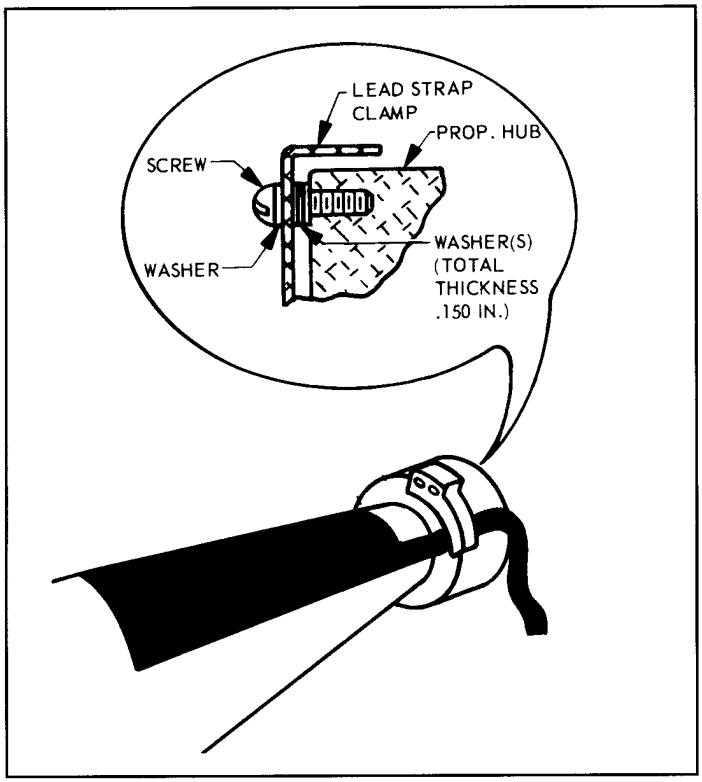
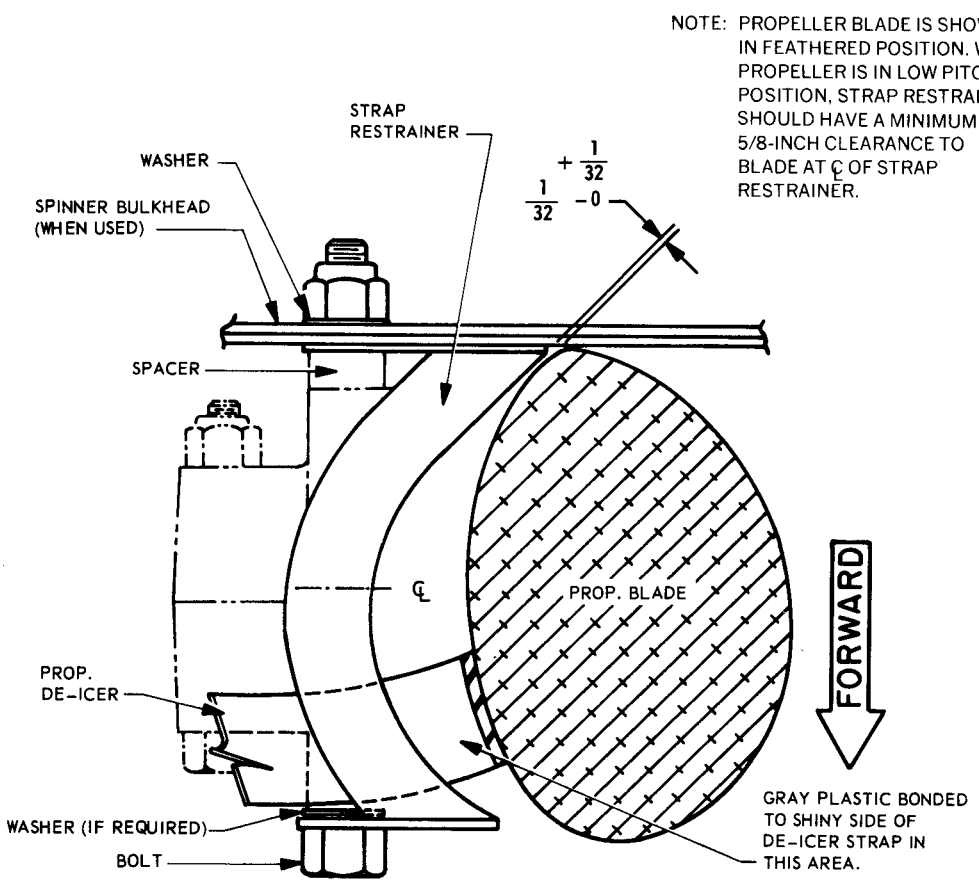


Figure 15 - Lead Strap (P/N 2E1087-3) Installation



R. H. INSTALLATION SHOWN; L. H. OPPOSITE

INSTALLATION

1. INSERT SPACER AS SHOWN AGAINST PROPELLER HUB.
2. POSITION STRAP RESTRAINER LEG AGAINST SPACER.
3. CHECK FOR CLEARANCE BETWEEN OTHER LEG OF STRAP RESTRAINER AND PROPELLER HUB. IF ANY, INSTALL WASHERS FOR SNUG FIT.
4. INSTALL BOLT. DO NOT USE WASHER UNDER BOLT HEAD.
5. IF NO SPINNER BULKHEAD IS USED, INSTALL WASHERS AS REQUIRED (MINIMUM ONE) TO PREVENT NUT FROM BOTTOMING OUT ON BOLT.
6. POSITION STRAP RESTRAINER TO MAINTAIN CLEARANCE AS SHOWN.

NOTE:

STRAP RESTRAINERS SHOULD BE INSTALLED AS SHIPPED — IN MATCHED SETS BY COLOR.
YELLOW PARTS ARE INSTALLED ON NORMALLY ROTATING (R.H.) PROPELLERS.
BLUE PARTS ARE INSTALLED ON COUNTERROTATING (L.H.) PROPELLERS.

Figure 16 - Restrainer Strap Installation

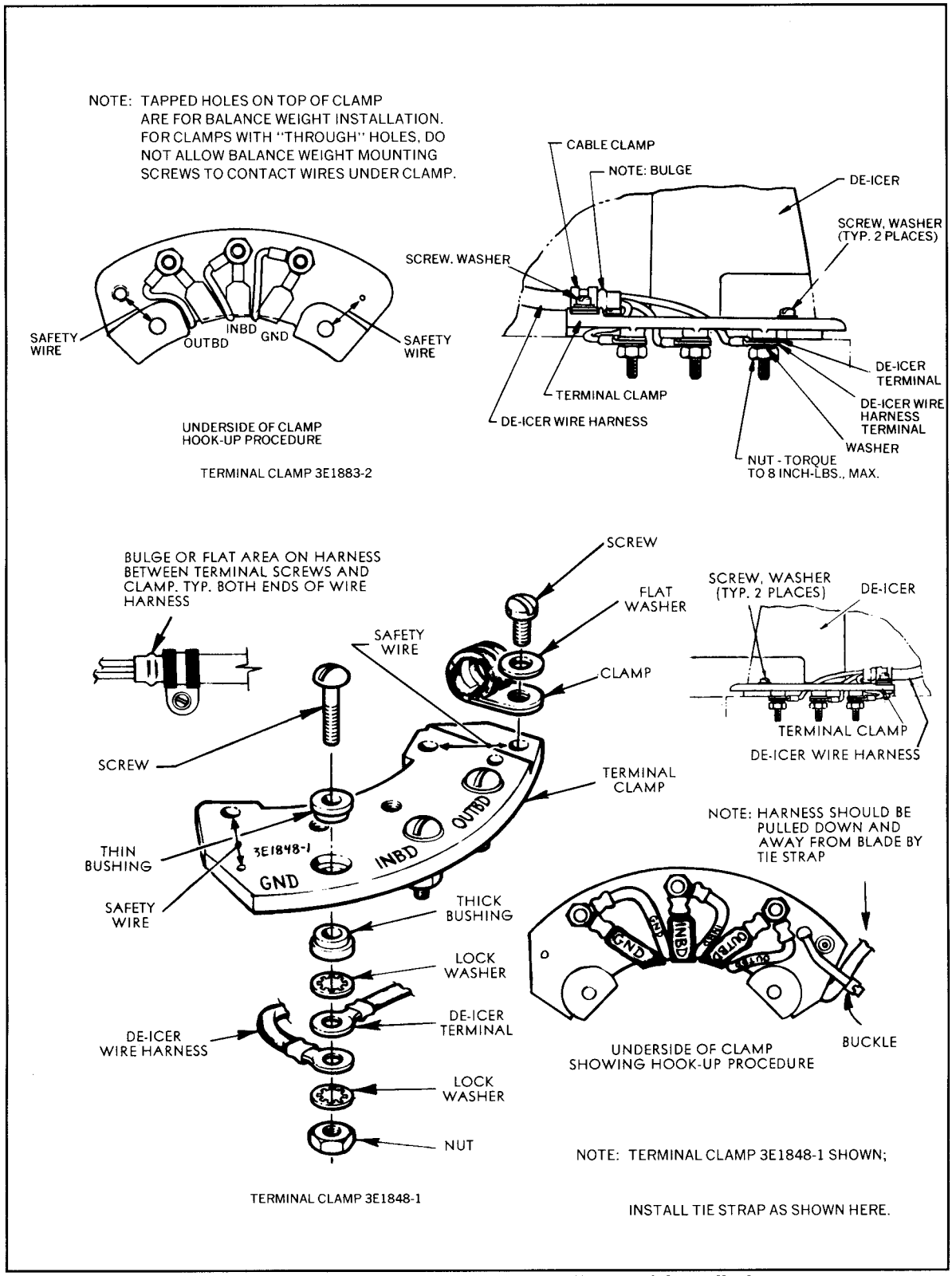


Figure 17 -Terminal Clamp (P/N 3E1883-2/3E1848-1) Installation

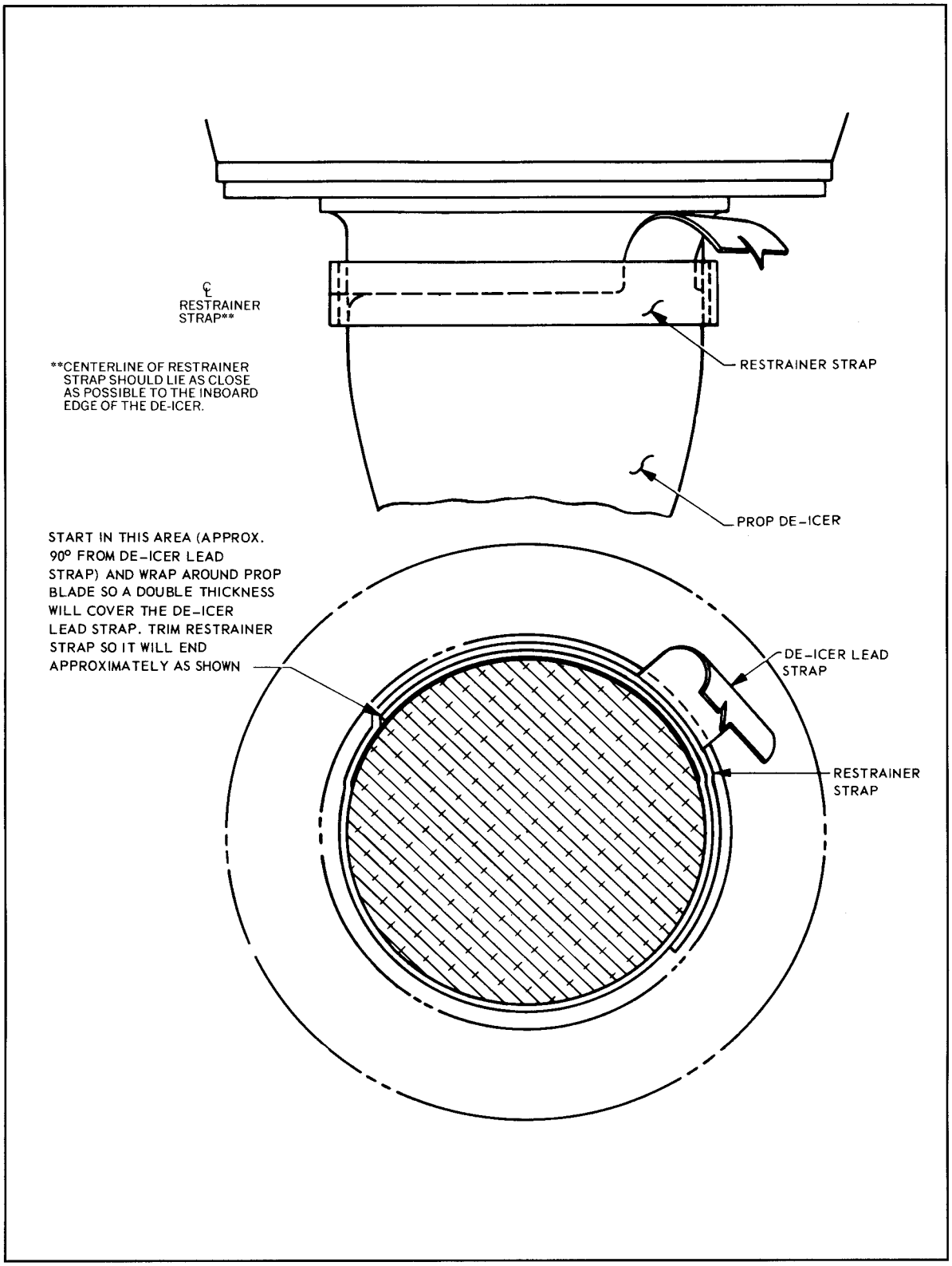


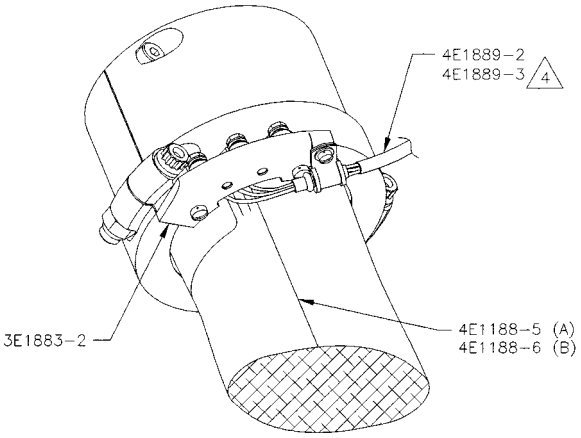
Figure 18 - Rubber Restrainer Strap (2E1291/3E1470) Installation

H. Quick Disconnect System (QDS)

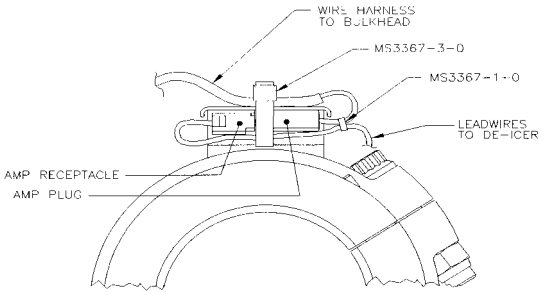
1. The Goodrich QDS simplifies prop de-icer and wire harness installation, minimizing components and de-icer replacement turn time.
2. QDS is available for HC-B3TN and HC-B4TN Hartzell Props. **Table 1 , this page**, shows groups of components for which a QDS kit can be substituted.
3. Reference Goodrich Service Newsletter 99-050 for QDS installation eligibility by prop and aircraft model.
4. Reference Goodrich ATA #30-60-25 for QDS installation instructions.
5. Reference **Figures QDS1-QDS3, pages 16-18** for installation illustrations.

TABLE 1 – COMPONENT GROUPS REPLACEABLE WITH QDS

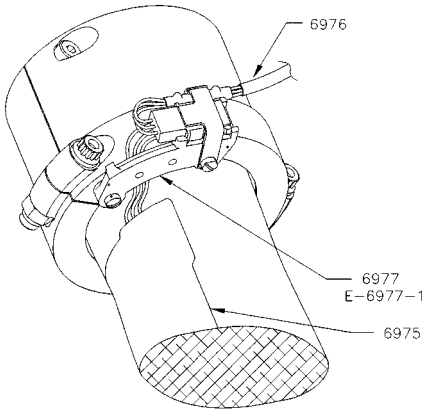
Group A **(3-wire normal rotating)**	**Group B** **(3-wire counter rotating)**
4E1188-5 de-icer –or- 4E1188-6 de-icer –and- 3E1883-2 terminal clamp –and- 4E1889-2 wire harness –or- 4E1889-3 wire harness	4E1601-5 de-icer –and- 3E1848-1 terminal clamp –and- 4E1889-2 wire harness
Group C **(6975-1 quick disconnect kit)**	**Group D** **(2-wire normal rotating)**
6975 de-icer 6976 wire harness 6977 hardware kit	4E2200-10 de-icer 3E2092-2 wire harness –or- 3E2092-3 wire harness



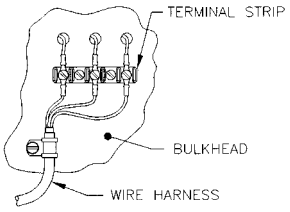
SYSTEM (A)/(B)



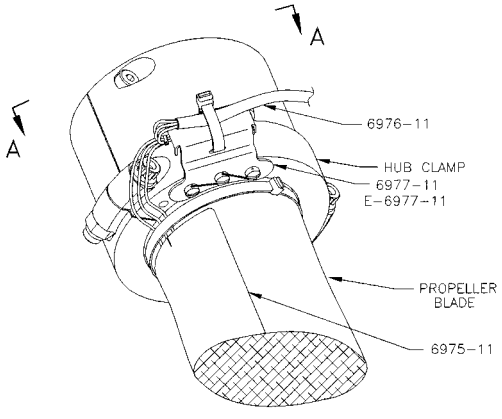
VIEW A-A



6975-1 DE-ICER KIT



6976-11 WIRE HARNESS CLAMP CONFIGURATION



6975-10 DE-ICER KIT

Figure QDS1
QDS installation for three wire normal rotating prop installation (Group A, Table 1 page 15) and for 6975-1 installation kits (Group C, Table 1, page 15)

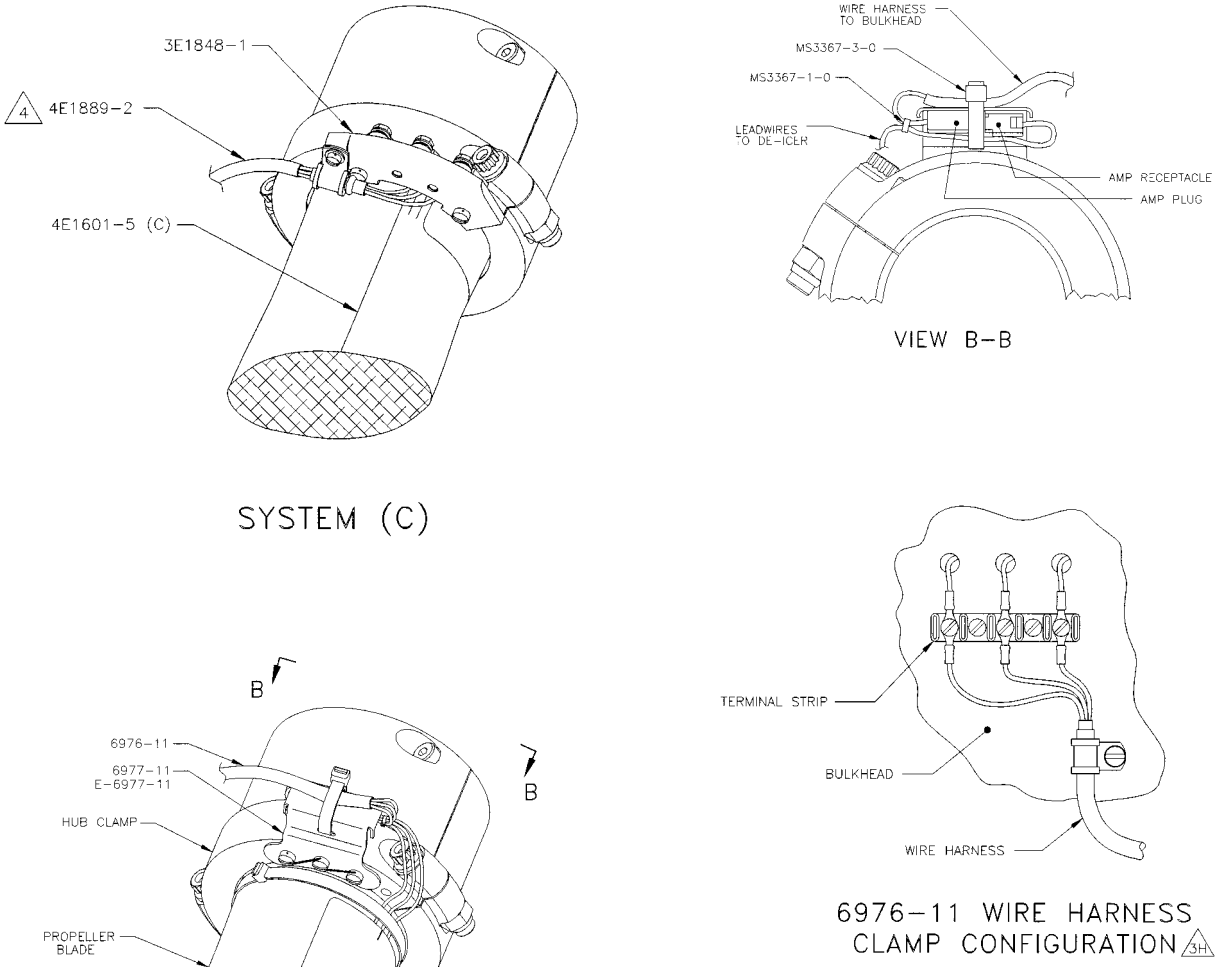


Figure QDS2
QDS installation for three wire counter-rotating prop installation
(Group B, Table 1, page 15)

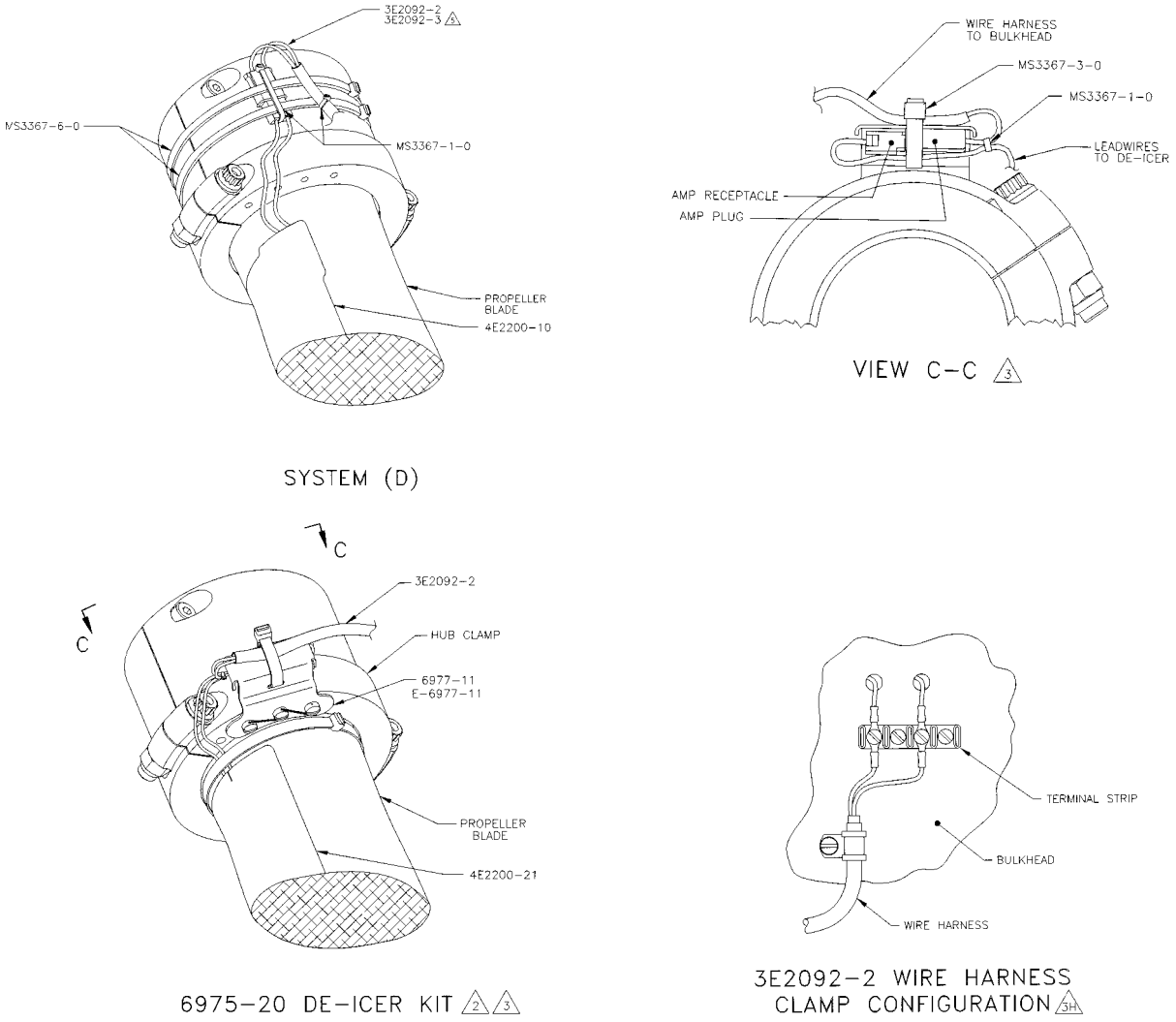


Figure QDS3
QDS Installation for two-wire normal rotating prop installation
(Group D, Table 1, page 15)

I. Timer Installation

1. Locate timer as specified in AMM. If not specified in AMM, check drawing for timer dimensions and locate in appropriate available space. Timer leads must be at least 8" away from radio input leads.
2. Install timer per one of following methods **(Figure 19, this page).**
   a. Bulkhead – Use timer as template to locate holes for hardware and attach directly to bulkhead.
   b. Adjustable mounting plate – Use mounting plate as template over stringers or ribs to locate hardware. Attach mounting plate and use timer as template to locate attachment hardware. Attach timer to mounting plate. If mounting plate does not overlap timer case completely, use spacer washers between timer and plate.
   c. One piece mounting plate – Use mounting plate as template over stringers or ribs to locate hardware. Attach timer to mounting plate.

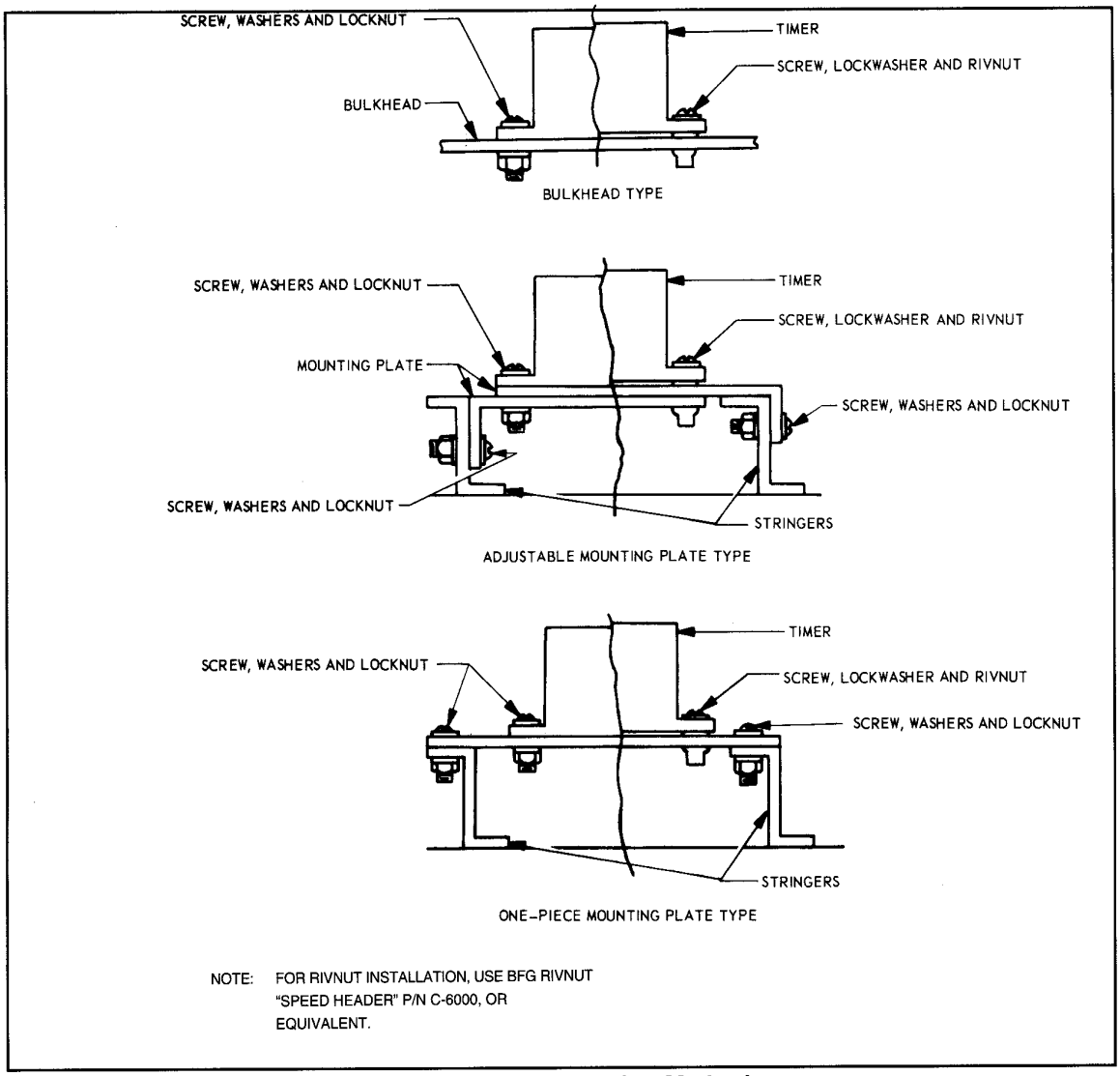


Figure 19 - Timer Mounting Methods

J. Ammeter, Switch, Circuit Breaker Installation

CAUTION: Type and quantity of de-icers determine system current drain. Optional components such as ammeter, switch and circuit breaker, are designed to operate at that current. Only components specified for the aircraft can be used without affecting de-icing system operation. Consult Goodrich Replacement Parts List and/or AMM parts list before ordering replacement components.

When optional components are specified, locate per FAA Part 23, Section 23.1321, and following guidelines. Check AMM or drawing for dimensions and terminal size of optional components.

1. Install ammeter in instrument panel. If an external shunt is used, install with 6” or shorter wire length between ammeter and shunt . Install switch and ammeter near each other. If warning placard required, install adjacent to switch in full view of pilot or as specified in AMM.
2. Check AMM for circuit breaker mounting location.

K. Brush Assembly Mounting Bracket Installation

Remove engine hardware and attach brush assembly mounting bracket using hardware provided. **(Figures 20-24, pages 21-23)** Remainder of brush assembly is installed after slip ring installation.

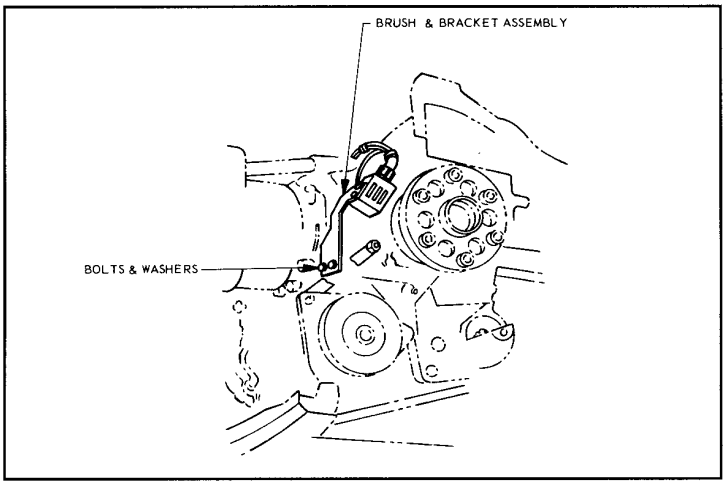


Figure 20 -Typical Brush Assembly Mounting Bracket Installation

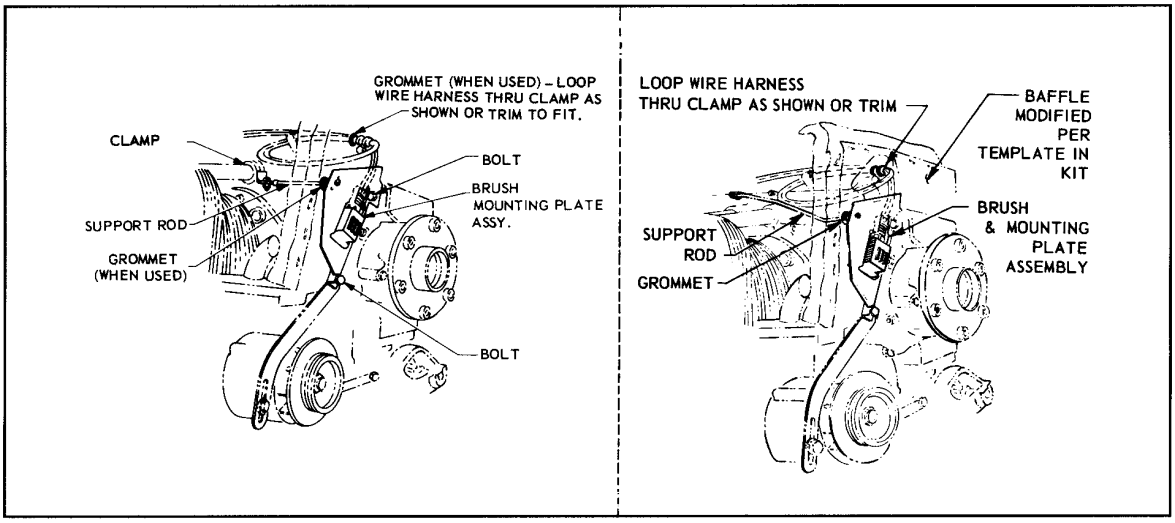


Figure 21 - Typical Brush Assembly Mounting Bracket Installations

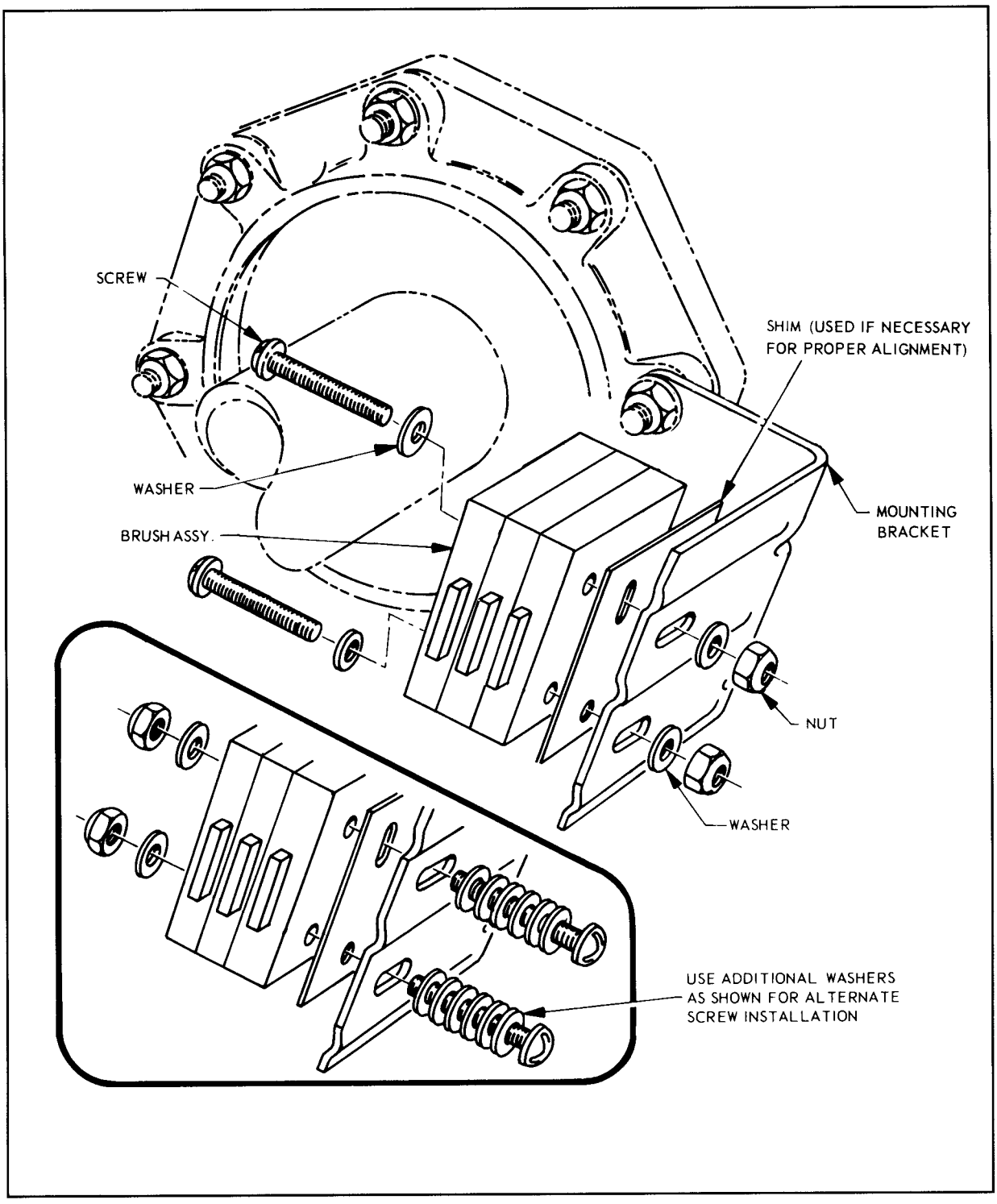


Figure 22 - Typical Brush Assembly Mounting Bracket Installation

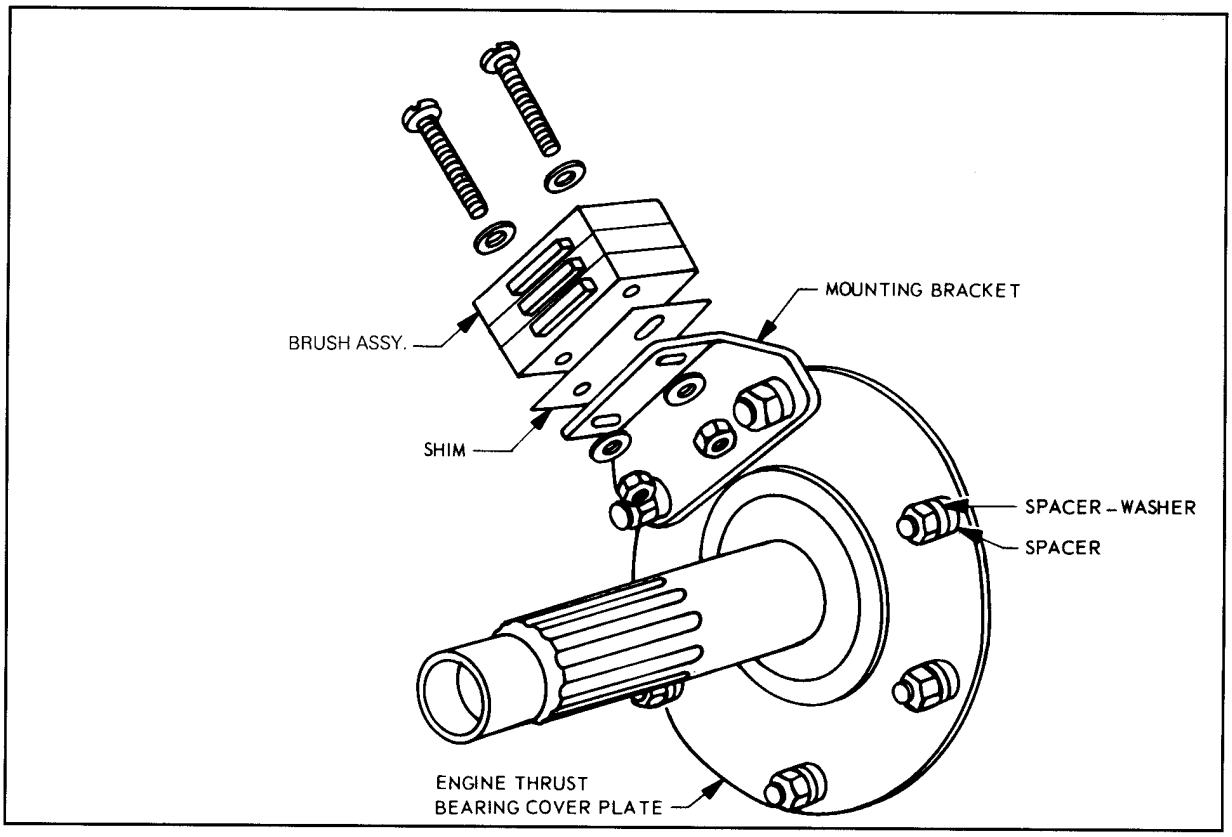


Figure 23 - Typical Brush Assembly Mounting Bracket Installation

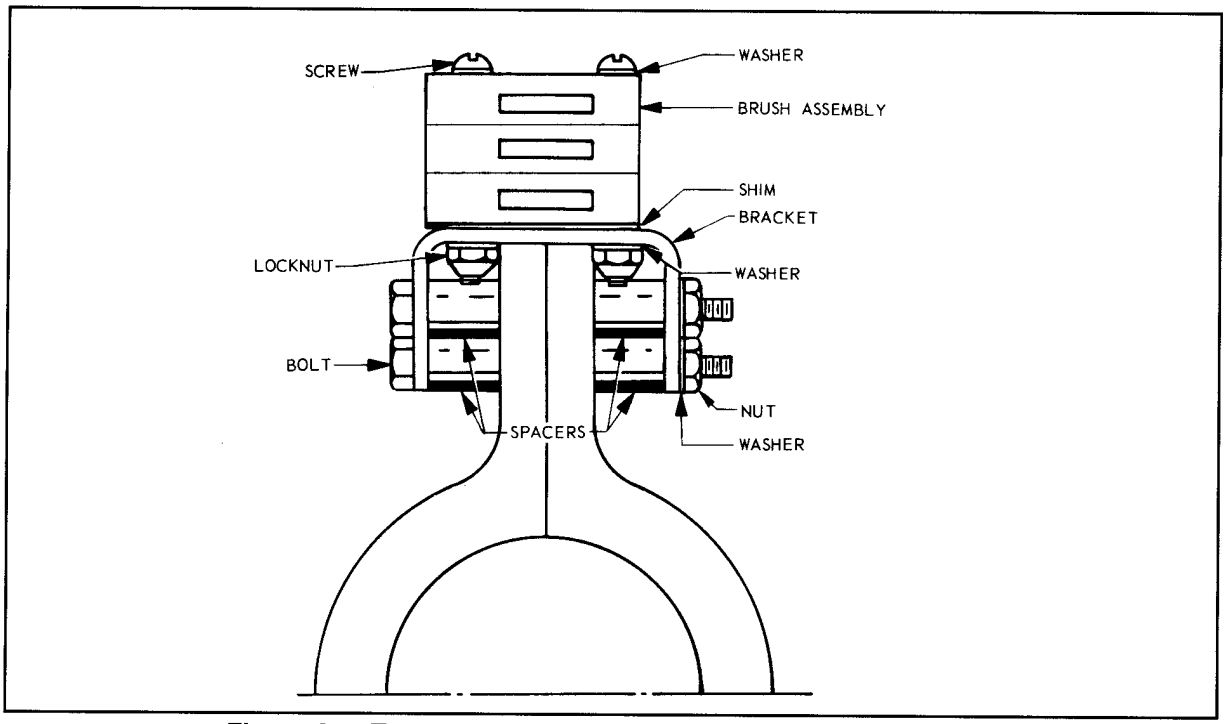


Figure 24 - Typical Brush Assembly Mounting Bracket Installation

L. Slip Ring Installation

1. Install connecting hardware provided, usually terminal strip block, on modified spinner bulkhead. **Figures 25-28, pages 24-25** show typical connections. Assure de-icer or wire harness leads are securely clamped. When directed by AMM, install rivnuts or grommets before installing terminal strip or block.

Typical Spinner Bulkhead Connecting Hardware

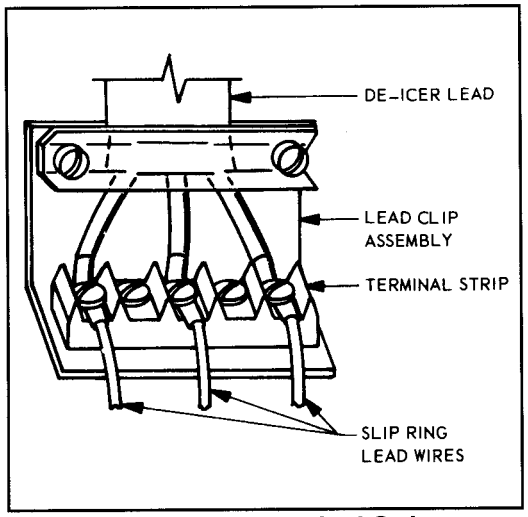


Figure 25 - Terminal Strip

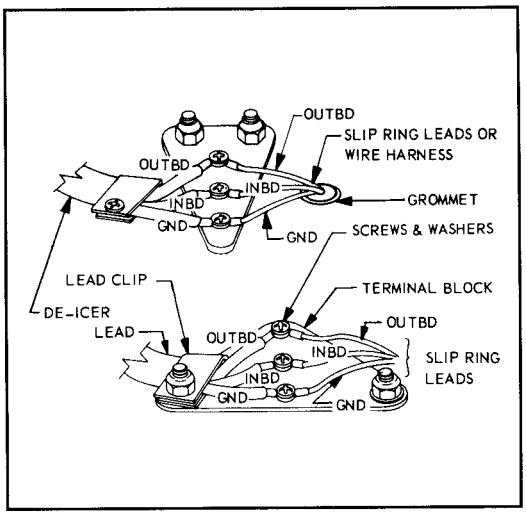


Figure 26 - Terminal Block

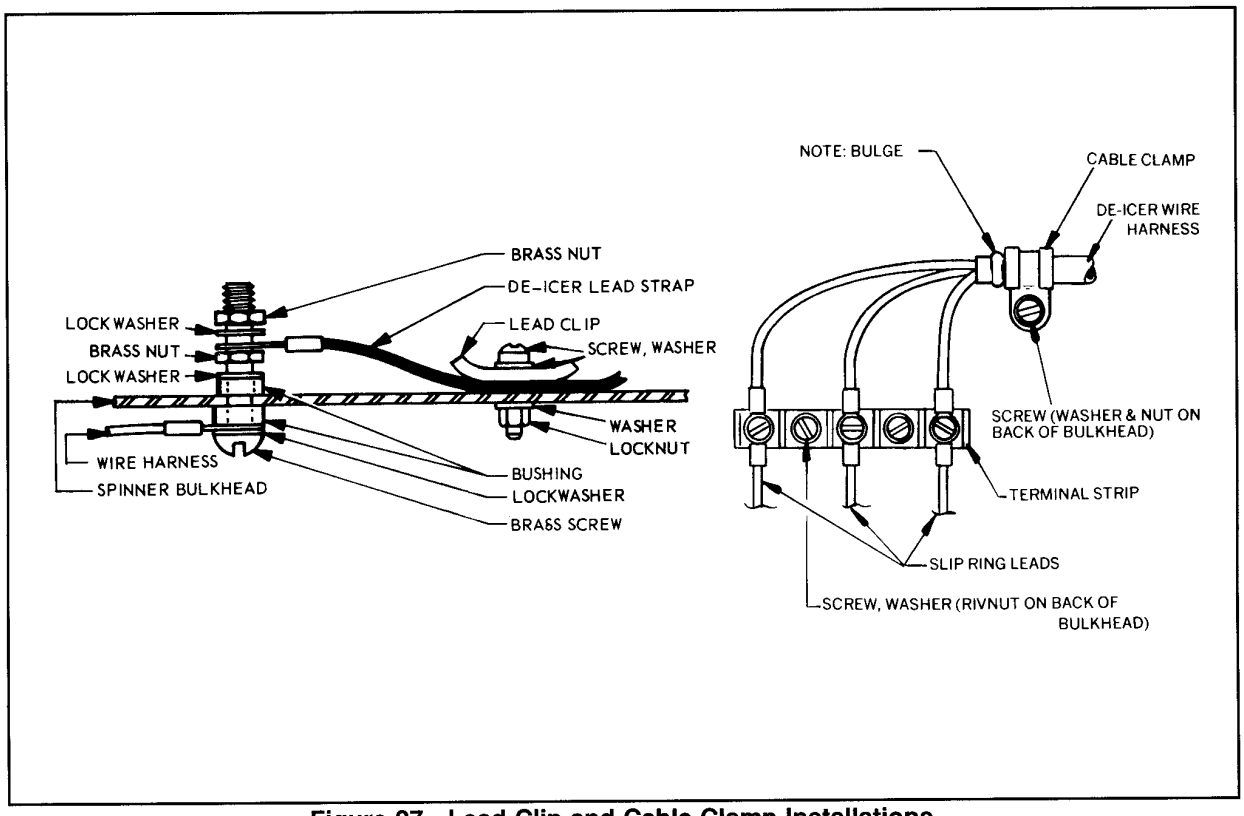


Figure 27 - Lead Clip and Cable Clamp Installations

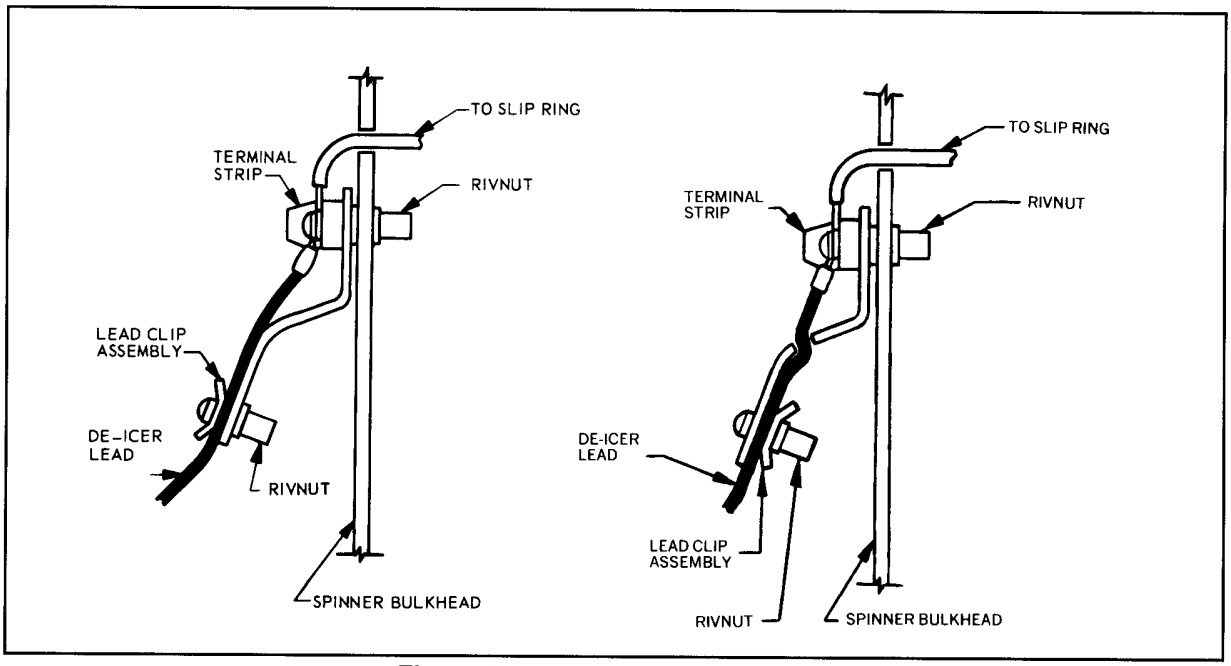


Figure 28 - Terminal Strip Variations

2. Slip Ring Assembly Installation

a. Install slip ring assembly as specified in AMM per one of two installation methods below.

i. Feed slip ring leads through holes drilled in spinner bulkhead during modification procedure. **(Paragraph C1, Section II, page 5)** If specified in AMM, install rubber grommets. Secure slip ring assembly to bulkhead with appropriate hardware. Hand ream mounting holes for satisfactory alignment. Torque bolts for snug fit. **(Figure 29, this page)**

ii. Position slip ring assembly on crankshaft or prop hub flange as specified in AMM **(Figures 30 & 31, page 27).**

b. Slip Ring Assembly Wiring

i. Connect slip ring leads as specified in AMM, either directly to terminal strips, blocks or studs, or using slip ring wire harness.

ii. Connect de-icer or wire harness leads to terminal strips, blocks or studs, and hold in place with lead clips as specified in AMM. Leave no slack in de-icer or wire harness leads between terminals and clips, and secure leads as specified in AMM. Do not twist leads more than 180° when aligning.

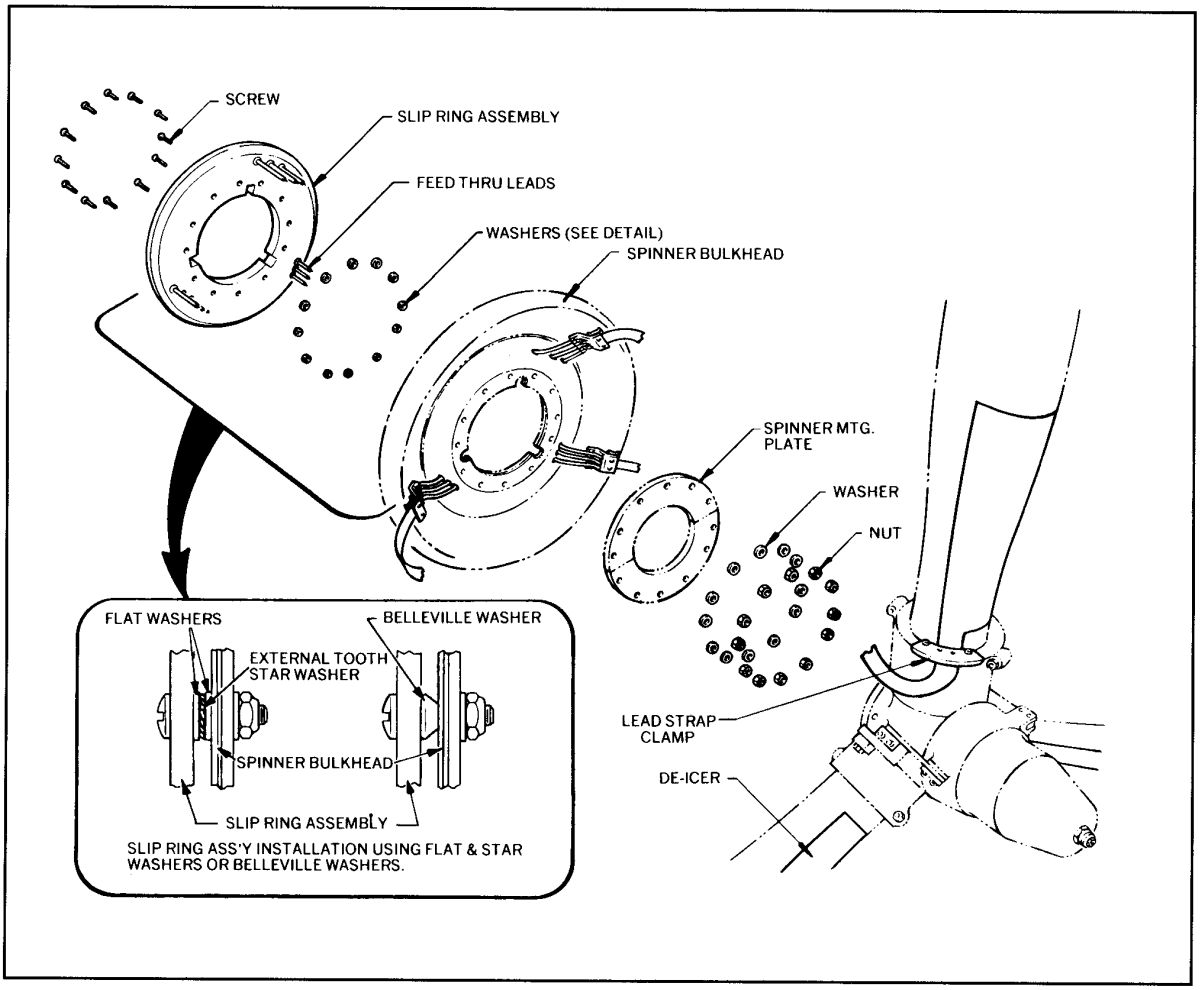


Figure 29 - Slip Ring Assembly Mounted on Spinner Bulkhead

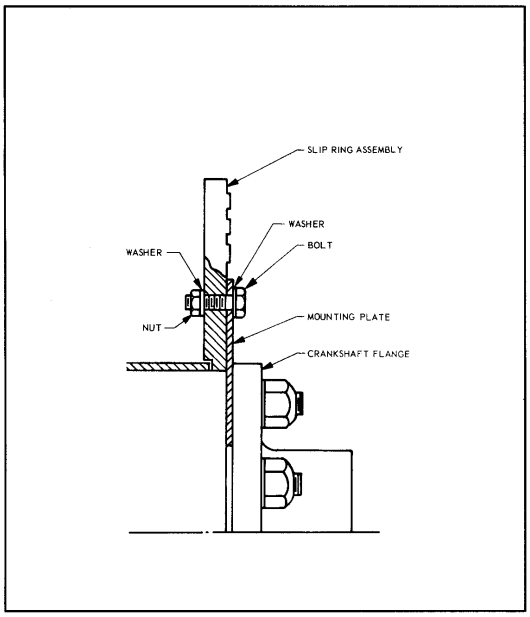


Figure 30 - Slip Ring Assembly Installation Method on Crankshaft or Propeller Hub Flange

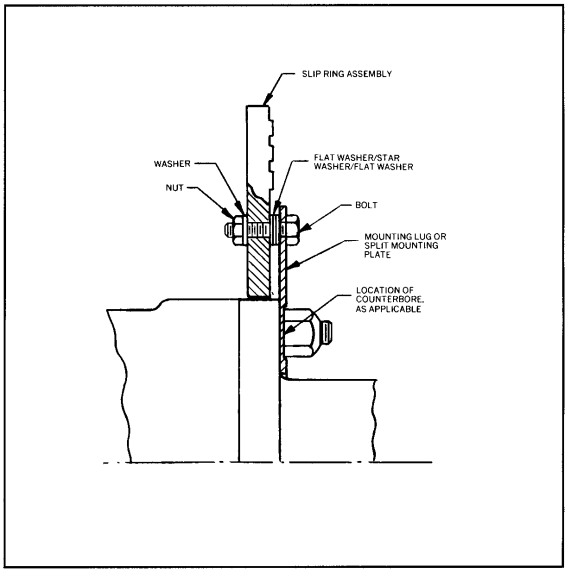


Figure 31 - Slip Ring Assembly Installation Method on Crankshaft or Propeller Hub Flange

3. Slip Ring/Starter Ring Gear Assembly Installation **(Figure 32, page 28)**

CAUTION: Before filing spinner adapter ring make sure spinner adapter ring is properly aligned on slip ring/starter ring gear assembly by matching location of spinner attaching nuts on spinner adapter ring flange.

a. If there is a spinner adapter ring, remove it from original starter ring gear and position over slip ring/starter ring gear assembly as it will be mounted.

b. If slip ring is installed outside starter ring gear pulley, file spinner adapter ring as required for a minimum 1/16” clearance between spinner adapter ring and slip ring terminals, making sure filed clearance areas have smooth and flowing radii. **(Figure 33, page 29)**

c. If slip ring is installed inside pulley on starter ring gear, there should be no interference between adapter ring and starter ring gear. Attach adapter ring to slip ring/starter ring

gear assembly with original bolts and finger tighten. (Bolts will be torqued later.) Install slip ring/starter ring gear assembly on crankshaft.

d. If there is no adapter ring, there is a hub extension, and the slip ring/starter ring gear assembly is installed between the crankshaft flange and hub extension **(Figure 34, page 29)**. Secure hub extension and install prop per PMM or AMM.

e. Slip Ring/Starter Ring Gear Assembly Wiring

Note: Be sure to connect matching leads or matching studs and leads: GND to GND, etc. Do not twist de-icer or wire harness leads more than 180° when aligning to terminals. Secure de-icer or wire harness leads with lead clips, and install cushions **(Figure 7, page 7 & Figure 32, this page)**, when specified in AMM. Leave no slack in leads between terminals and clips.

i. With a spinner adapter ring, de-icer or wire harness, leads connect to integral terminal studs **(Figure 32, this page & Figure 33, page 29)** or attached terminal strips/blocks on slip ring/starter ring gear assembly, using adapter ring attachment bolts **(Figures 25 & 26, page 24).**

- With terminal strips/blocks, slip ring/starter ring gear assembly leads and de-icer or wire harness leads both connect to strips/blocks.
- With integral terminal studs, de-icer or wire harness leads only connect to studs using 10-12 inch-lbs. Torque to tighten nuts.

ii. If terminal strips, clips or other hardware are installed using same bolts that attach adapter ring to slip ring/starter ring gear assembly, make sure there is 2-3 thread engagement beyond nut. On aircraft with spinner bulkhead(s), a slip ring wire harness is installed on the slip ring/starter ring gear assembly terminal studs, connects to de-icer or wire harness leads, is routed across hub extension, and connects to terminal strips or studs on modified spinner bulkhead **(Figure 33, page 29)**.

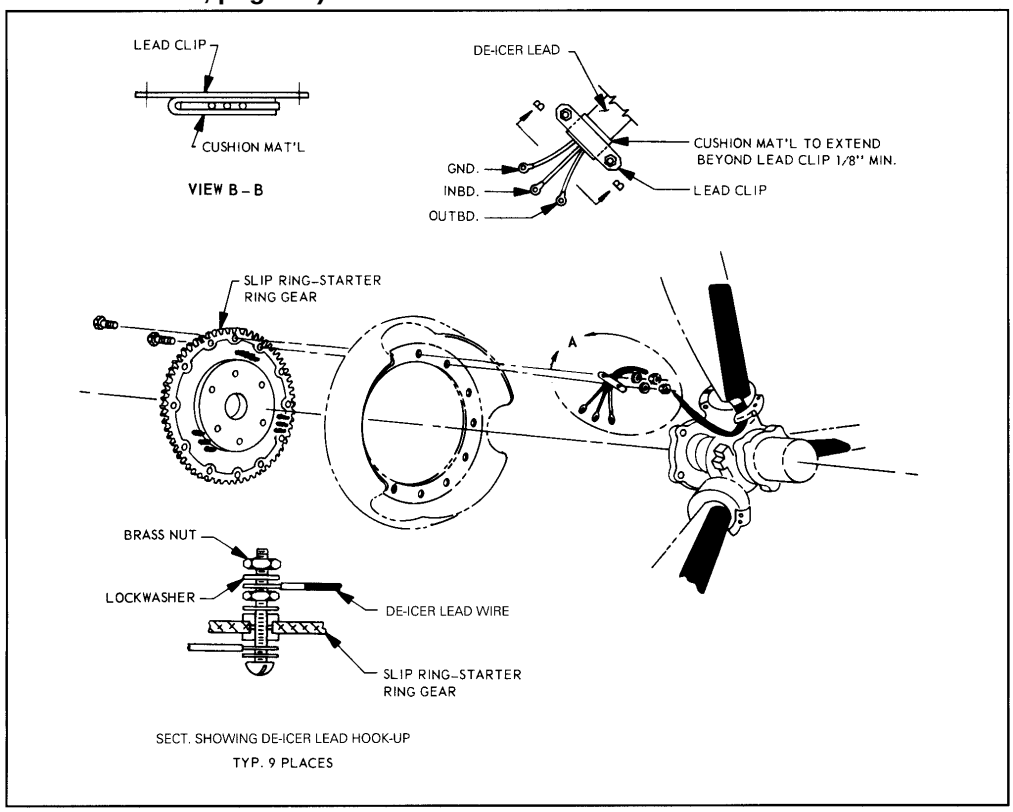


Figure 32 - Typical Slip Ring/Starter Ring Gear Assembly Installation

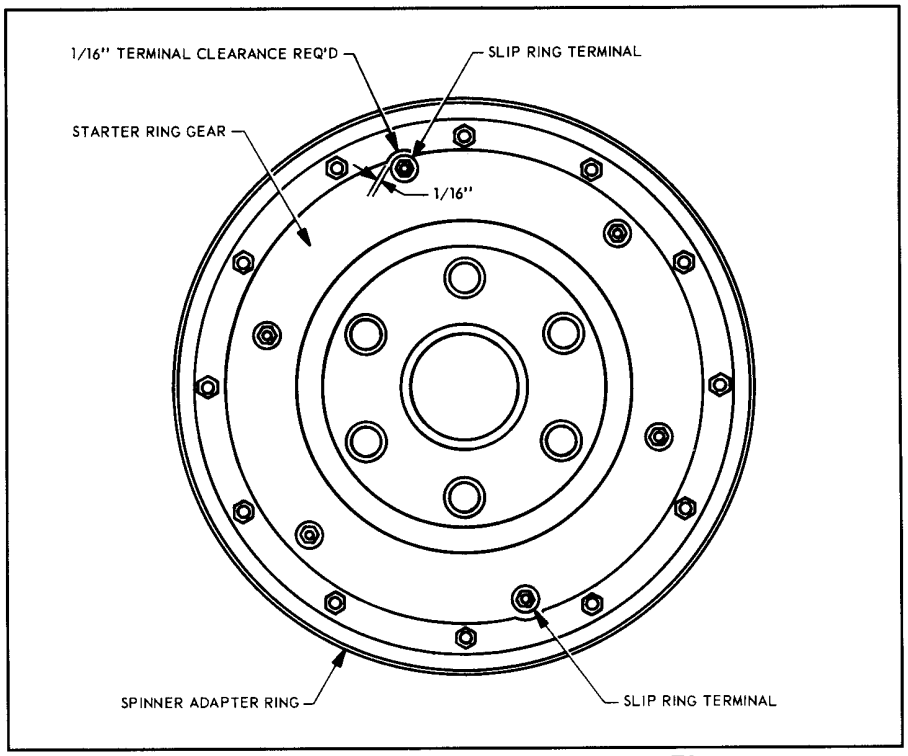


Figure 33 - Positioning Spinner Adapter Ring

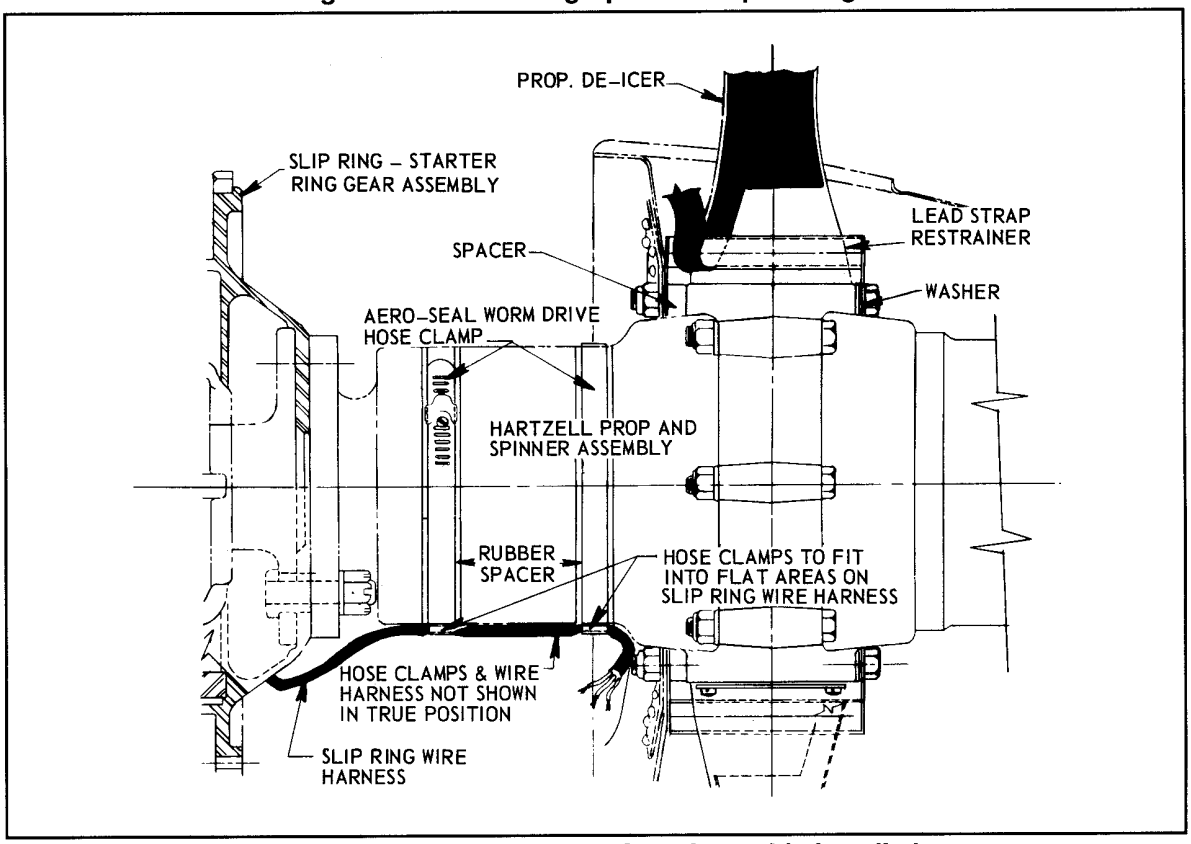


Figure 34 - Slip Ring/Starter Ring Gear Assembly Installation

4. Hose Clamps

If there is a hub extension with slip ring or wire harness leads routed along the hub, hose clamps may be used to hold wiring against hub **(Figure 34, page 29)**. If so, drill cap guards on hose clamps with No. 56 drill as shown in **Figure 35, this page**. Drill both sides of cap guards in line with and near screw slot base. Position clamps, spacers and cushions as applicable per AMM. Position worm screw housings 180° opposite each other on hub extension. Do not place wire harness in tension when tightening clamps. Torque worm screws to 35-55 inch-lbs. And safety wire.

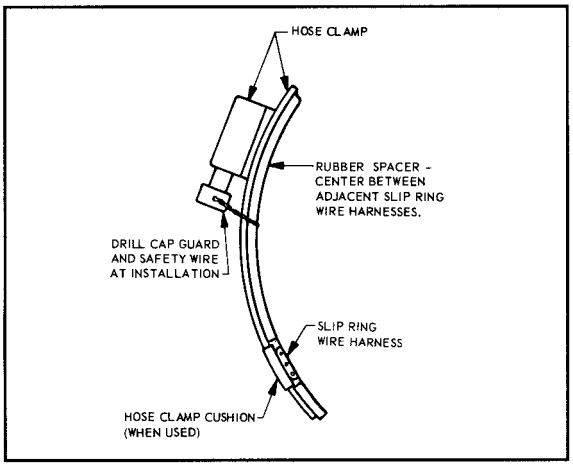


Figure 35 - Hose Clamps

5. Slip Ring Run-out (Alignment)

a. After installation, check slip ring alignment by attaching a dial indicator gauge to the engine and placing the pointer on the copper ring **(Figure 36, page 31).** Grasp prop blade and rotate slowly, noting deviations of ring from true plane. Exert uniform push or pull on prop to make sure run-out reading is accurate. Total run-out reading must not exceed .0050" (±0025") for piston engines, or .0080" (±0040") for turbine engines. Additionally, run-out reading must not exceed .0020" within any 4" arc of slip ring travel for either engine type.

b. If slip ring/starter ring gear assembly is used, or if slip ring assembly is mounted between crankshaft flange and prop hub, and run-out reading is unacceptable, check for dirt on ring gear mounting surfaces or slip ring holder and clean as required. If run-out reading is still unacceptable, return slip ring to Goodrich (through point of purchase) for evaluation.

CAUTION: Torque adjustment/shim procedures cannot be used for slip rings mounted between crankshaft flange and prop hub.

c. If slip ring is mounted on spinner bulkhead, and run-out reading is unacceptable, vary torque on attachment bolts within limits specified by PMM or AMM, or within standard limits for bolts used. Most slip ring installations include a compression washer arrangement that allows proper ring adjustment by varying torque applied to attaching hardware **(Figure 29, page 26).**

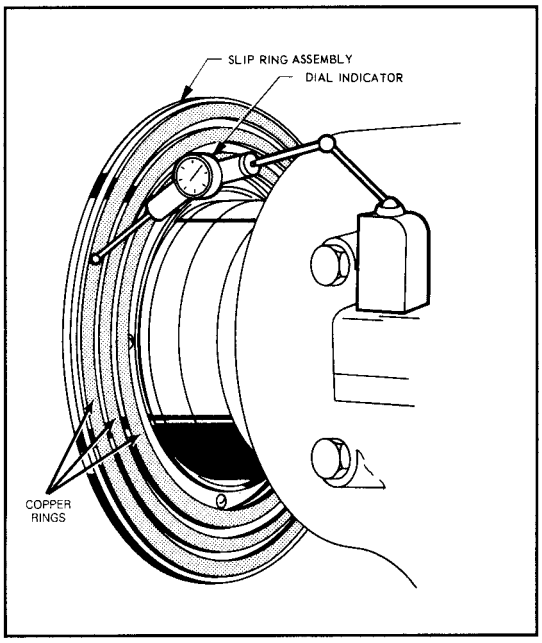


Figure 36 – Checking Slip Ring Run-out

M. Propeller Assembly Installation

Install spinner bulkhead and prop per PMM or AMM.

N. Brush Assembly Installation

1. Position brush assembly on mounting bracket installed in **Paragraph K, Section II, page 20** careful not to damage brushes by exerting side load. Install attachment hardware but do not torque at this time.
2. Three brush assembly alignments are critical to smooth, efficient and quiet electric power transfer from brushes to slip rings.

   a. Projection — Distance between brush assembly and slip ring should be between 1/32" and 3/32" **(Figure 37, page 32)**. Adjust distance as required by loosening hardware attaching brush assembly, and holding brushes in while tightening hardware. Slotted holes are usually provided for this purpose.

   b. Face — Entire face of each brush must contact copper ring throughout full 360° slip ring rotation **(Figure 38, page 32)**. Face alignment can be adjusted by loosening and tightening procedure described above. Face alignment can also be adjusted by using shims between brush assembly and mounting bracket. Make shims of metal layers .003" thick, not to exceed .020" thickness overall.

   c. Angular — Cock brushes at a 2° angle from perpendicular on copper rings **(Figure 37, page 32)**. Adjust as required using methods shown in **Figures 39-41, page 32.**

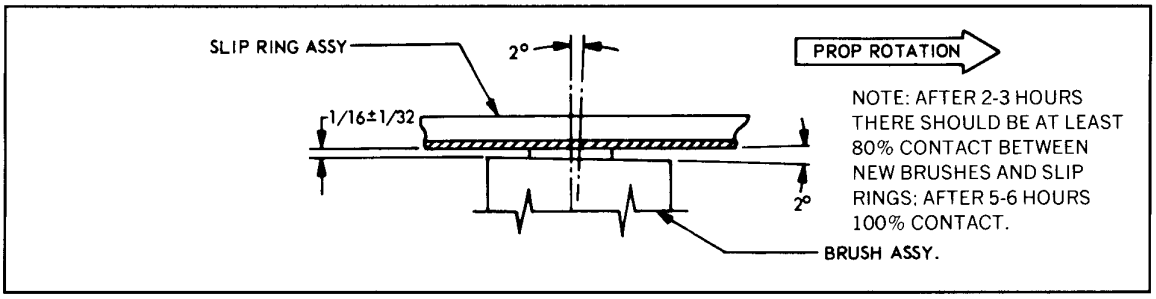


Figure 37 - Brush Alignment - Projection

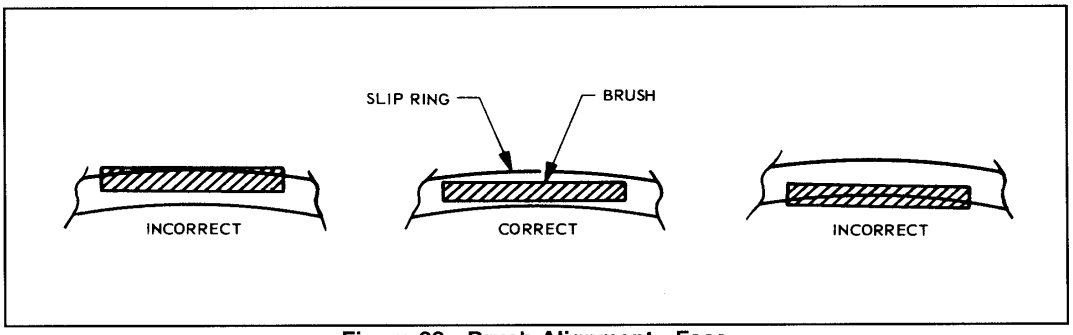


Figure 38 - Brush Alignment - Face

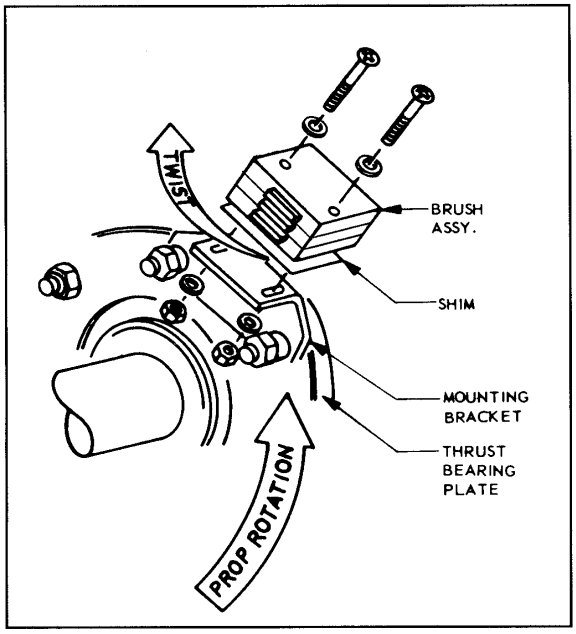


Figure 39 - Angular Brush Alignment Adjustment Method

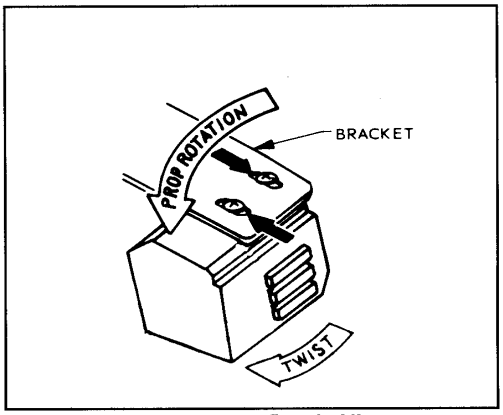


Figure 40 - Angular Brush Alignment Adjustment Method

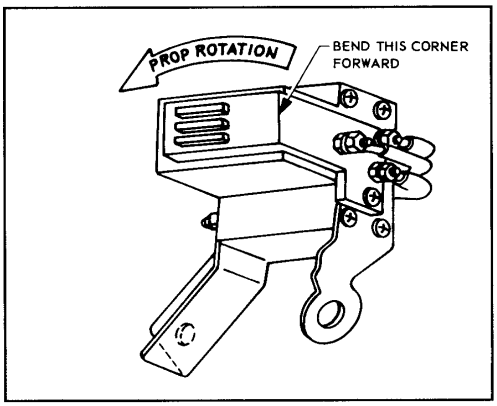


Figure 41 - Angular Brush Alignment Adjustment Method

O. System Wiring

CAUTION: Follow AMM procedures and FAA Advisory Circular 43.132 when cutting holes into pressurized compartments to install wiring. Holes must be air tight to pressure specified by AMM.

1. General

Consult AM for specific wiring instructions and schematic. Following general guidelines apply to all applications:

a. Secure or trim excess wire.
b. If wire harnesses are not provided, follow color coding and minimum wire sizes as specified in AMM to fabricate.
c. Make sure there is no interference with existing controls or equipment. Keep wires at least 8" away from radio input leads and/or moving cables.
d. When soldering, solder flow (wicking) must not extend onto any lead that is flexed. Use non-corrosive flux. Wipe or flush from leads and connector pins after soldering.
e. Route wiring to avoid contact with hot components or areas.
f. Firmly support and/or retain all wiring.

2. Timer Wiring

CAUTION: When timer is not properly grounded, de-icing system will not function correctly.

Timer has box-mounted receptacle or terminal strip. Timer wire harness connector plug or terminals connect to de-icing system. If timer wire harness not provided, consult AMM for appropriate connector plugs or terminals, proper wire size and color coding for fabrication. Attach timer ground wire to mounting screw or adjacent ground point.

3. Ammeter Wiring

Attach timer wire harness to negative ammeter terminal with solder or with crimp-on terminal. If there is an external shunt, connect shunt terminals to ammeter and timer per AMM.

4. Switch or Circuit Breaker/Switch Wiring

Connect positive side of ammeter or shunt to bottom terminal of switch or circuit breaker/ switch with wire harness provided or with correct size and color wire. Connect wire from top terminal of ammeter or shunt to bus bar if no other components are used. Use crimp-on terminals or solder.

5. Circuit Breaker Wiring

Connect switch or circuit breaker/switch to circuit breaker with wire harness or correct size and color wire per AMM. Connect circuit breaker to bus bar. Attach wires with crimp-on terminals or solder.

6. Engine Firewall Connector Wiring

If an electrical connector through the engine firewall is required, use MS3100 plus MS3106 or MS3108 style connector **(Figure 42, page 34)**. If connectors through other panels or bulkheads are specified, use a doubler if panel is not rigid enough to support connector. Use receptacle as template to locate attachment hardware.

7. Brush Assembly Wiring

Use wire harness, if provided, or solder connector plug MS3108A10SL-3S or MS3106A10SL-3S (or crimp-on terminal lugs) to connect brush assembly to engine wire harness. Assemble connector plug (or terminal lugs) to brush assembly receptacle or terminal pins. Make sure ground wire from brush assembly is attached to aircraft ground.

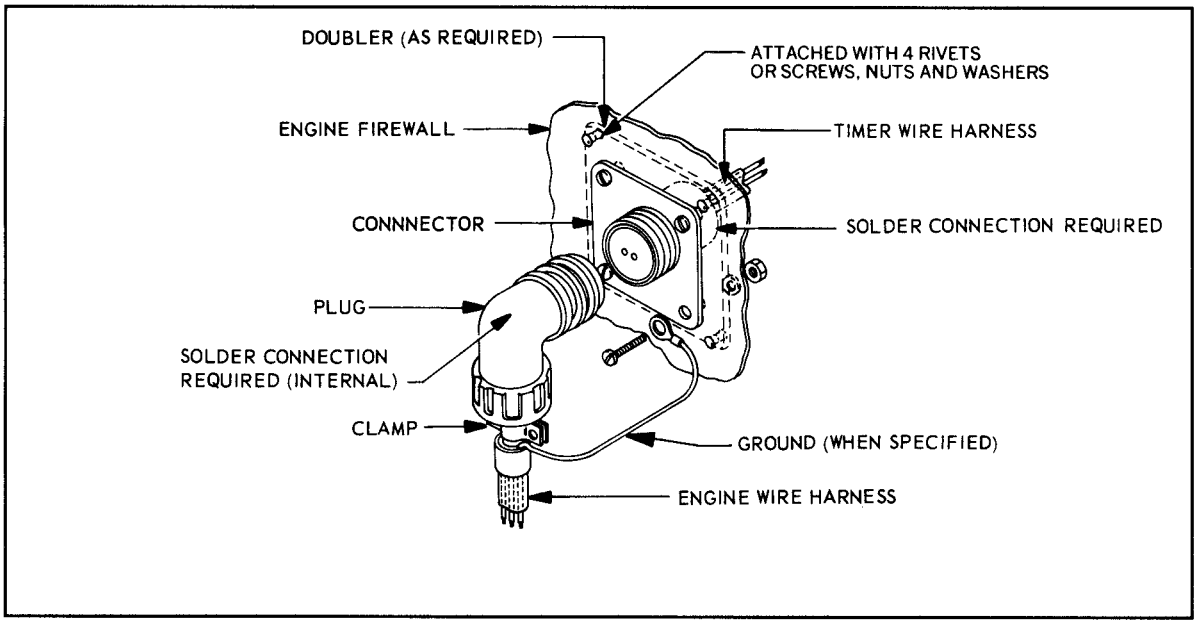


Figure 42 - Engine Firewall Connector

P. Post-Installation Inspection

1. Visually check completed installation. Check de-icers for wrinkling or loose spots. Check connections for integrity and snugness. Move prop from full low pitch through feathering position (and reverse pitch where applicable). De-icer or wire harness leads should not be placed in tension when prop is moved through full pitch range.
2. Check for radio noise or radio compass interference by operating engine at near take-off power with radio gear on, while turning de-icing system on and off. When noise or interference occurs with system on, and does not occur with system off, troubleshoot per **Table 4, page 44.**
3. Check brush alignment and adjust as required per **Paragraph N, Section II, page 31.**
4. Check de-icer resistance per Goodrich ATA 30-60-07.
5. Test the timer per **Paragraph E, Section III, page 39.**
6. Perform de-icer heat test per **Paragraph A4, Section III, page 35.**

SECTION III
PROPELLER DE-ICING SYSTEM AND COMPONENT MAINTENANCE

CAUTION: Do not operate de-icers continuously for more than 5 minutes above 100°F ambient temperature without allowing them to cool down completely.

Note: When checking system operation, use auxiliary power supply (APU). If APU is not available, do continuity check in place of inspection points requiring power.

A. 50-Hour Inspection

1. On turbine engines, check for fuel and/or oil leakage onto brushes and slip rings. Fuel and/or oil contamination cause excessive brush wear and slip ring grooving. Stop leaks and remove build-up between copper rings that can cause electrical shorting. Clean and refurbish or replace brushes and/or slip rings, as required.
2. Remove spinner dome and open access doors as required to facilitate wiring inspection.

Note: A properly calibrated ammeter is required for this procedure.

3. If system has no ammeter, install test ammeter in timer power input line. Check AMM for operating range of de-icing system. Have assistant observe ammeter with de-icing system activated, and flex accessible wiring, especially de-icer, wire harness and slip ring leads, firewall electrical connectors and associated wiring. Ammeter needle movement outside shaded range, (other than normal flicker from cycling of certain timers), indicates short or open circuit. Pinpoint location of problem by checking continuity of wiring while flexing and prodding suspected area. Correct as required.
4. Perform de-icer heat test to confirm proper heating sequence:
   a. Have assistant activate system.
   b. Feel de-icer area that should be heated during each phase of cycle.
   c. Have assistant record ammeter reading and call out each phase to verify sequence. (With certain timers, ammeter needle flickers when timer cycles to each phase).
   d. Temperature rise should be noticeable to touch when de-icer heats. Hot spots indicate surface damage or loose bond that requires de-icer replacement or rebonding.
5. Reinstall spinner dome if removed.
6. Lock brakes and operate engine at near take-off power. Activate de-icing system and observe ammeter for 2 minutes 12 seconds. Needle should rest within shaded area throughout complete cycle. (With certain timers ammeter needle may flicker outside shaded area as timer cycles to each phase.)

B. 100-Hour Inspection

CAUTION: Do not run up engine with spinner dome removed. De-icer or wire harness lead failure can occur.

1. If applicable, feather props. Remove spinner dome and open access doors as required.
2. Visually check de-icers for wrinkled, loose or torn areas, particularly around outboard end and where de-icer or wire harness leads pass under lead strap clamp or restrainer. Look for abrasion or cuts, especially along leading edge and flat or thrust face. Check that lead strap and terminal clamps, tie straps or restrainers are secure and properly installed. **(Figures 8-18, pages 8-14 or QDS1-3, pages 16-18, as applicable)** Look for cracks or other damage. Check that screws are safety-wired.

Note: All de-icers on a prop must be located same distance from hub for rotational balance.

3. Check that de-icer or wire harness leads are not placed in tension. When tension exists, check for slack between lead clip and terminal studs, or between lead strap clamp or restrainer and de-icer. If there is no slack, or if tension still exists after eliminating slack, check de-icer part number and location dimension in AMM or PMM, drawing or Goodrich Prop Replacement Parts List. If location dimension is incorrect, remove de-icer and rebond at correct dimension. If wrong de-icer part number is installed, replace with correct part number.
   If de-icer wire harnesses are used, check that terminals and terminal studs are not shorting out to each other or prop hub. Inspect wire harnesses for chafing or shorting. Remove source of chafing and refurbish or replace wire harnesses. Check that lead clips and terminal screw assemblies are in good repair.
4. Perform de-icer heat test per **Paragraph A4, Section III, page 35.**

C. Slip Ring Inspection

1. Thoroughly clean the slip ring with MEK (methyl ethyl ketone) solvent or a suitable degreasing solution. Inspect the slip ring's general condition: look for excessive wear, roughened surfaces, cracks, burned or discolored areas, oil, grease and/or dirt deposits and loose copper rings. Inspect for grooves in the copper rings.
2. If slip ring wear is uneven or wobble is noticed, check slip ring run-out per **Paragraph L5, Section II, page 30**, and adjust.
3. If there are grooves deeper than .007" reface the unit at the next opportunity per the procedure below. To assure that sufficient slip ring material remains to reface, measure the X, Y or Z dimension as shown in **Figure 43, page 37**, and compare it to the minimum dimension in **Table 2, Slip Ring Minimum Dimension Chart, page 38.**
4. If the grooves are not deeper than .007", inspect the surface finish of the copper rings. The finish should be smoothed out to at least a 32 micro-inch finish if the slip ring is to continue in service without refacing. Smooth the grooves with crocus cloth or equivalent to obtain the required finish.
5. Check flatness of the slip mounting surface. The mounting surface must be flat within .005" overall.
6. Slip Ring Machining (Refacing) Procedure

CAUTION: Do not exceed the X, Y or Z minimum dimensions on Table 2, Slip Ring Minimum Dimension Chart, page 38. Do not machine the outer edge of a slip ring holder with syncrophaser targets, and do not machine the starter ring gear portion of a slip ring/starter ring gear assembly.

Note: It is recommended that the slip ring be mounted on a rigid, flat, machined plate with mounting holes matching the slip ring hole pattern. The mounting plate provides a firm support to prevent chatter when cutting the copper ring surfaces. It is also recommended that the mounting surface of the plate be refaced for flatness each time installed in the lathe. This insures a consistently flat surface for mounting the slip ring in the lathe.

   a. Mount the slip ring in the lathe so that the concentricity of the inside diameter of the aluminum holder is within .002" TRI (total indicated run-out) over 360° of rotation.
   b. Set the rotational speed of the lathe at 600-900 RPM. Feed rate should be .005-.008" per revolution.
   c. Use a synthetic diamond tipped tool with a 1/64" to 1/32" corner radius to obtain a good surface finish. A carbide insert tool with a TIN (titanium nitride) coated insert with a 1/64" to 1/32" corner radius is acceptable.

CAUTION: Excessive heat build-up in the copper rings can result in the rings' debonding from the epoxy potting. A continuous application of kerosene is strongly recommended to aid in cutting and to prevent tool chatter and reduce heat build-up. Do not use cutting fluids or coolants other than kerosene, as they may react with the copper

rings, causing discoloration and/or leaving a contaminating residue. If kerosene is not available, machine the slip ring dry.

d. Take light cuts at a depth of no more than .002" to .004" per pass at the specified feed rate and RPM. Remove the minimum amount of material required to achieve complete removal of grooves or damage. Final surface finish should be at least 32 micro-inches.

e. Insure that the contact surfaces of the copper rings are parallel to the mounting surface within .005" overall, and that the flatness is within .002" over a 4.0" arc.

Note: Undercutting the insulation is no longer required, so long as the procedure described here is followed.

f. Debur the slip ring edges with emery paper and thoroughly degrease the entire slip ring with MEK.

g. Check the insulation resistance between the copper rings and the slip ring holder with a Megger tester with 500 VDC applied. The resistance must be at least .05 megohms after 15 seconds.

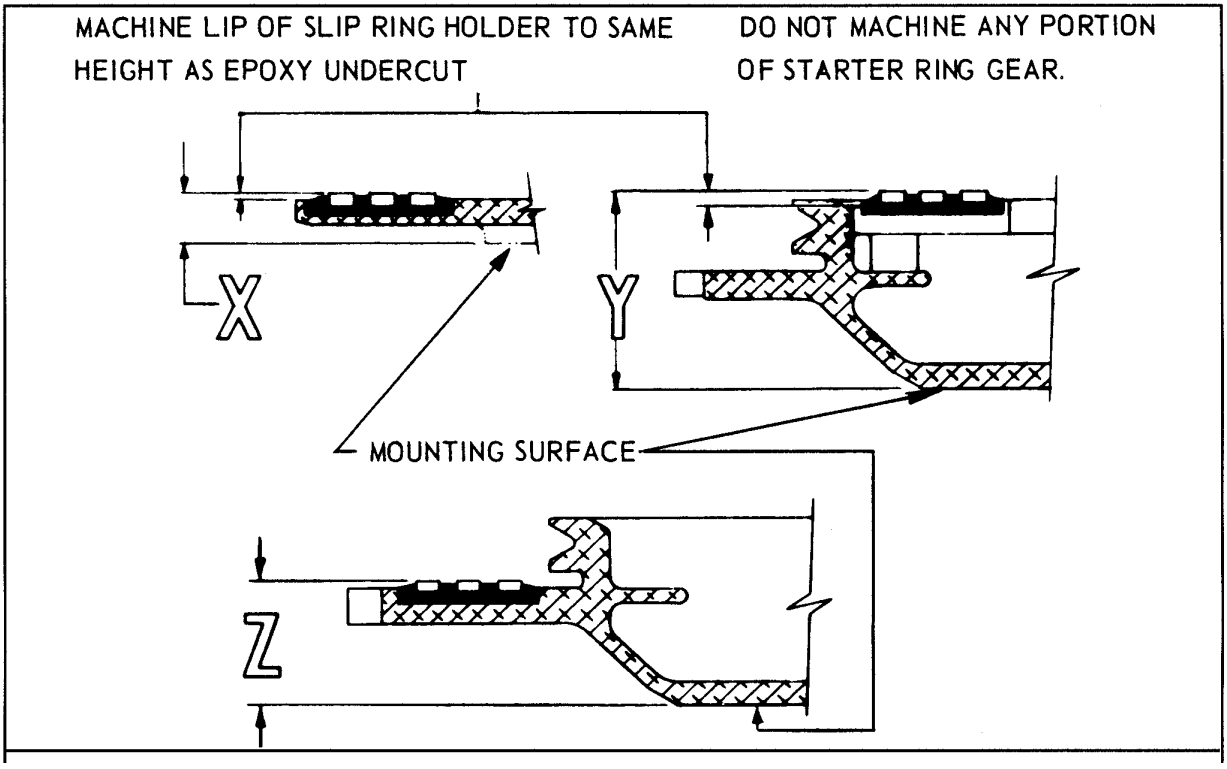


Figure 43 – Measuring Slip Ring Minimum Dimension

TABLE 2 – SLIP RING MINIMUM DIMENSIONS

P/N	X Dim.	P/N	X Dim.	P/N	X Dim.	P/N	Y Dim.	Z Dim.
4E1287-1,2	.453	4E1874-1	.265	4E2448-1	.945	4E1187		1.900
4E1295-1	.390	4E1880-1	.300	4E2459	.285	4E1212		1.900
4E1295-2	.453	4E1882-1	.265	4E2468	.310	4E1239		1.900
4E1352	.300	4E1918-1	.235	4E2501	.440	4E1365-1,2,3,4,6	2.875	
4E1353	.300	4E1923-1,2,3	.295	4E2504	.285	4E1637-2	1.920	
4E1424	.453	4E1924-1,2	.295	4E2511	.295	4E1673	2.960	
4E1448	.328	4E1926-1	.235	4E2524	.425	4E1677	2.875	
4E1454	.828	4E1933-1 thru 5	.480	4E2551	.187	4E1686	2.960	
4E1474	.453	4E1933-6,7,8	.945	4E2590	.425	4E1943-1	2.825	
4E1489	.453	4E1948-1	.315	4E2624-1	.187	5E1421	2.960	
4E1494	.515	4E1964-1	.480	4E2626	1.330	5E1450	2.875	
4E1508	.300	4E1964-2,3,4	.945	4E2661-1,2,3	.275	5E1455-1	3.015	
4E1518	.328	4E1974	.410	4E2671-1,2	.310	5E1482-1	2.875	
4E1523	.328	4E1988-1	.295	4E2674-1,2,3	.275	5E1526-1		1.820
4E1526	.475	4E2087	.650	4E2714-1	.328	5E1541-1	3.015	
4E1526-4	.945	4E2115-1,2,3	.700	4E2761-1	.285	5E1549-1	2.950	
4E1555-1,2,3	.187	4E2155	.650	4E2830-1	.285	5E1551-1		1.800
4E1556	.328	4E2267	.295	4E2863	.714	5E1559-1	2.950	
4E1575	.421	4E2276	.285	4E2873	.295	5E1561-1	2.820	
4E1578	.453	4E2324	.295	4E2955-1	.480	5E1583-1	2.900	
4E1598	.328	4E2350-1	.945	4E2972	.220	5E1593		1.840
4E1614,-2	.265	4E2362	.285	4E3000-1	.490	5E1649	2.980	
4E1614-3	.945	4E2366	.945	4E3008-1	.595	5E1819	2.825	
4E1621	.300	4E2371	.235	4E3060	.271	5E1820	2.825	
4E1635	.300	4E2373	.650	4E3062-1	.610	5E1834	2.900	
4E1650	.328	4E2375-1	.235	4E3094-1	.480	5E1835	2.965	
4E1676-1thru-4	.187	4E2377-1	.650	4E3099-1	.187	5E1837	2.960	
4E1681	.300	4E2406	.285	4E3139-1	.290	5E1840		1.800
4E1706	.300	4E2412	.415	4E3148	.460	5E1851-2,-2	2.930	
4E1708	.300	4E2416	.945	4E3177	.685	5E1857-1,2,3	2.930	
4E1731-1	1.160	4E2422	.285	4E3219	.685	5E1892-1		1.820
4E1748-2	.475	4E2438-1,-2	.380	4E3236-1	.305	5E1895-1		1.820
4E1803-1	1.160	4E2440	.295	4E3236-2	.320	5E1901-1		1.800
4E1853-1	.390	4E2442-1	.187	4E3422-1	.235	5E1919	2.960	
4E1865-1	.475	4E2444-1	.187	4E4015-1	.480	5E1922	2.825	
4E1865-2,3	.945	4E2446	.295			5E1925-1	2.825	
						5E1932-1	2.930	
						5E1934	1.920	
						5E2296	2.840	

D. Brush Assembly Inspection

1. Check mounting bracket, brush block or brush modules for cracks, deformation and other damage. Check for grease, fuel and/or carbon deposits on brush assembly and between brushes. Clean with methyl ethyl ketone (MEK) or replace. Repair source of oil or fuel leakage.
2. Measure brush wear per Goodrich ATA 30-60-01, and replace brushes worn beyond specified limit. Check for uneven wear, chipping or breakage on brushes, and replace as required. Check brush assembly alignment per **Paragraph N, Section II, page 31** and adjust as required per **Figures 39-41, page 32**.

E. Timer Test

Note: Timer test is required **only** when de-icer heat test **(Paragraph A4, Section III , page 35)** or abnormal current reading indicates system malfunction.

1. Use APU with 24 to 32 VDC output, 15-amp capacity. Use 5 amps minimum load on each output.
2. Remove wire harness connector plug from timer and jump power input socket of wire harness to timer input pin.
3. Jump timer ground pin to ground.
4. Activate de-icing system.

Note: Some timers need warm-up period so first complete cycle may be longer than specified. Timer does not home when de-icing system is deactivated. When de-icing system is activated, timers with manual step features cycle power to next pin in sequence. Timers without manual step features require a full output sequence before cycling power to next pin.

5. Hold voltmeter probe on an output pin until voltage drops to 0. Move probe to next pin in sequence shown in **Table 3, page 40**. Check voltage at each pin in sequence. When correct sequence and interval time are verified, deactivate system. Check volts to ground per **Table 3, page 40.** If timer operates correctly remove jumper wires and replace connector plug. If timer operates incorrectly, return to a Goodrich authorized repair facility for evaluation.

TABLE 3 – TIMER OPERATION

P/N	System Voltage	Power Pin	Ground Pin	Control Pin	Manual Step	Ammeter Flicker**	Output Sequence (seconds)	Total Cycle (minutes)
3E1150-3*	28	B	G	N/A	YES	YES	C,D,E,F (34)	2.2
	14	B	A	N/A	YES	YES	C,D,E,F (34)	2.2
3E1150-7*	28	B	G	N/A	NO	NO	C,D,E,F (34)	2.2
3E1150-10	28	B	G	N/A	NO	NO	C,D,E,F (34)	2.2
	14	B	A	N/A	NO	NO	C,D,E,F (34)	2.2
3E1150-12	28	B	G	N/A	YES	NO	C,D,E,F (34)	2.2
	14	B	A	N/A	YES	NO	C,D,E,F (34)	2.2
3E1899-1	28	B	A	N/A	N/A	N/A	C (90)	1.5
3E1964-1	28	B	G	N/A	YES	NO	C,D (34)	1.1
	14	B	A	N/A	YES	NO	C,D (34)	1.1
3E1964-2	28	B	G	N/A	YES	NO	C,D (20)	0.7
	14	B	G	N/A	YES	NO	C,D (20)	0.7
3E1964-3	28	B	G	N/A	YES	NO	D,F (90)	3.0
	14	B	A	N/A	YES	NO	D,F (90)	3.0
3E1964-4	28	B	G	N/A	YES	NO	C,D (34)	1.1
	14	B	A	N/A	YES	NO	C,D (34)	1.1
3E1964-5	28	B	G	N/A	YES	NO	C,D (45)	1.5
	14	B	A	N/A	YES	NO	C,D (45)	1.5
3E2205-1	28	A	F	N/A	YES	YES	C,E (34)	1.1
3E2205-3	28	A	F	B	YES	YES	C,E (90)	3.0
3E2205-4	28	A	F	B	N/A	N/A	C (90 ON/90 OFF)	3.0
3E2205-6	28	A	F	B (slow)	YES	YES	C,E (34)	1.1
	28	A	F	D (fast)	YES	YES	C,E,DWELL (17)	0.9
3E2205-7	28	B	G	N/A	YES	YES	D,F (90)	3.0
3E2205-8	28	A	F	B	YES	YES	C,E (34)	1.1
3E2205-9	28	J	A	B (slow)	YES	YES	K,M (90,90)	3.0
3E2205-12	28	A	F	B (slow)	YES	YES	C (90 ON/90 OFF)	3.0
	28	A	F	D (fast)	YES	YES	C (45 ON/180 OFF)	3.0
3E2205-13	28	A	F	B (slow)	YES	YES	C,E (34)	1.1
	28	A	F	D (fast)	YES	YES	C,E,DWELL (17)	0.9
3E2205-14	28	J	A	B (slow)	YES	YES	K,M (90)	3.0
	28	J	A	C (fast)	YES	YES	K,M,DWELL (45)	2.3

* Obsolete, superseded by 3E1150-10 or –12

** Ammeter flicker is subjective. If problems suspected due to unexpected ammeter flicker or non-flicker, contact Goodrich for assistance.

F. Ammeter Test

1. Check ammeter by connecting calibrated test ammeter or volt-ohmmeter with ammeter scale, into de-icing system circuit between bus bar and system ammeter. Activate system and check amperage reading on test ammeter. Reading should agree with reading on system ammeter. Deactivate system and remove test ammeter or volt-ohmmeter. If readings are different, and de-icing system operates satisfactorily, replace system ammeter.
2. If the timer and ammeter tests are satisfactory, circuit breaker and switch are functioning correctly. If testing is unsatisfactory, and timer and ammeter check out satisfactorily, repair or replace circuit breaker and/or switch.

G. Wiring

1. Repeat the 50 hour inspection for wiring.
2. Visually and by touch, check clamps, clips, mountings, electrical connections and connectors for tightness and electrical integrity. Check for loose, broken or missing safety wire. Adjust or replace components or safety wire.
3 Check for radio noise or radio compass interference by operating engine at near take-off power with radio gear activated, while turning de-icing system on and off. When noise or interference occurs with system on, and does not occur with system off, troubleshoot per **Table 4, page 44.**

R H. Lightning Strike Inspection

1. Visually inspect de-icers for obvious signs of damage: pinhole punctures or blistering. Replace as required.
2. Visually inspect wire harnesses, terminal strip connections, slip ring assembly and brushes for damage: scorching, melted leads and/or shorted connections. Replace damaged parts as required.
3. In de-icing systems with Metal Oxide Varister (MOV) assemblies, replace MOV assemblies in all cases of lightning strike.
4. After above inspection and replacement of MOV assemblies (if applicable), perform a functional test of the system to assure proper cycling of timer and correct current draw per system design.

I. System Troubleshooting

1. Use system ammeter to troubleshoot most electrical problems as shown in **Table 4, page 44**. When de-icing system does not have an ammeter, install properly calibrated test ammeter between bus bar and timer to troubleshoot.
2. Helpful Tips
   a. Normal current range with engine running is marked by shaded area on ammeter face. Check AMM for current range when system ammeter is not used.
   b. Use de-icer heat test **(Paragraph A4, Section III, page 35)** and ammeter test **(Paragraph F, Section III, page 41)** to determine which de-icer or de-icer element is not operating properly. Use wiring schematic in AMM to trace circuits, and isolate problem.
   c. Excess current reading indicates power lead shorted to ground. Locate short circuit and correct.
   d. Use a Megger (or other tester having a 500 VDC, 100 megohm capacity) for insulation resistance tests.
   e. If ammeter reading is inside shaded area when props are not rotating, and outside shaded area on low side when props are rotating at cruise RPM's, check for defective wiring in prop mounted components.

3. De-Icer Resistance Check

a. First Reading: To measure de-icer resistance or to locate short or open circuit at brush to slip ring contact, disconnect engine wire harness at brush assembly, and use low range ohmmeter or Wheatstone bridge to read resistance of each de-icer circuit lead to brush assembly ground pin. Correct de-icer resistance values are shown in Goodrich ATA 30-60-07.

b. Second Reading: When actual values differ from chart, disconnect de-icer or wire harness leads at spinner bulkhead or starter ring gear and measure resistance of each de-icer element. When first reading differs from chart, and the second reading matches, look for trouble in brush to slip ring contact. When both first and second readings differ from chart, de-icer or wire harness is damaged.

4. Slip Ring Run-Out Check

Note: Severe arching and brush wear often occur when there is "wobble" in the slip ring assembly. Wobble occurs because the slip rings do not run in a plane perpendicular to the center line of rotation of the prop shaft. Slip ring wobble will cause rapid deterioration of the slip ring-brush contact surfaces and eventual failure of the de-icing system.

a. Perform Run-Out Test per **Paragraph L5, Section II, page 30.**
b. If the total run-out is exceeded, note the amount and location.
c. Remedy for slip ring/starter ring gear assemblies and slip rings mounted between prop shaft and engine flanges
   i. Remove slip ring, clean mounting surfaces, reinstall and check run-out.
   ii. If run-out is still exceeded, machine slip ring per **Figure 43, page 37.**

CAUTION: Do not shim or vary torque of prop attachment bolts.

d. Remedy for slip rings <u>not</u> mounted between prop shaft and engine flanges
   i. Vary torque of attachment bolts over the range of:

      65-100 in-lbs for ¼-28 bolts, screws or hylock pins
      21-32 in-lbs for 10-32 screws or bolts
      100-150 in-lbs for 5/16-24 bolts
      40-100 in-lbs if Belleville washers are used

   ii. If slip ring run-out is still excessive, make small (up to .005" max.) washer-shaped shims and place them on the attachment bolts (limit one per bolt) between the slip ring and its mounting surface. Vary torque per Step I above and perform run-out test again.
   iii. Adjust shim height and vary torque until s lip ring run-out is within tolerance. If prop run-out cannot be achieved, check flatness and structural integrity of mounting surface. If mounting surface is satisfactory, remove slip ring and clean per. Place on flat surface and check run-out. If necessary, resurface slip ring per **Figure 43, page 37**, install and align.
   iv. After slip ring is aligned, realign brush assembly as required with respect to newly aligned slip ring.

5. Brush Assembly Resistance Check

a. To check for open or short circuit or for high resistance in brush assembly, use low range ohmmeter or Wheatstone bridge to measure resistance from brush face to brush receptacle pin. Probe should contact at least 1/16" square area on brush. When resistance value is more than 0.013 ohms, locate and repair cause of excessive resistance or replace brush assembly components as required.

b. For brush block assemblies only (does not apply to modular brush assemblies), measure insulation resistance between three terminal studs or connector pins, and from pins to connector housing. Value should be at least 0.50 megohms after one minute. When value is lower, check for short circuit between brush leads. To correct short circuit, replace insulating tubing.

6. Ammeter Check

a. If ammeter is externally shunted, check that the ammeter and shunt are correctly matched by checking the shunt notation. Shunts with “30 amps = 50 MV” are used with 0-30 amp range ammeters. Shunts with “50 amps = 50 MV” are used with 0-50 amp range ammeters. Check shunt by disconnecting ammeter leads and connecting a millivoltmeter across the shunt. Activate the de-icing system and check the millivoltmeter reading. If the ammeter scale is 0-50, the millivoltmeter ready should be the same as the ammeter reading. If the ammeter scale is 0-30, the millivoltmeter reading should be 1-2/3 (167%) of the ammeter reading. Check the ammeter by connecting a test shunt of proper value or using an adjustable 0-50 millivolt source. Check for correct reading with the de-icing system activated. If the readings from the ammeter and shunt do not agree, replace whichever is defective.

b. If ammeter is internally shunted, connect a properly calibrated test ammeter in series with the system ammeter. Make sure the test ammeter is calibrated to $\pm$ 2% full range accuracy or better. Activate the de-icing system and check readings on both ammeters. If the readings do not match, replace the system ammeter.

TABLE 4 – TROUBLESHOOTING

Trouble	Probable Cause	Remedy
Ammeter shows zero current all phases of timer cycle	No power from aircraft	If no voltage into circuit breaker, locate and correct open circuit.
	Tripped circuit breaker caused by short circuit	Locate and correct short circuit, then reset circuit breaker.
	Faulty circuit breaker or switch	If correct voltage at circuit breaker input and no voltage at output, and circuit breaker does not reset, replace circuit breaker. If correct voltage at switch, test ammeter per **Paragraph F, Section III, page 41,** and replace as required.
	Faulty ammeter	Test ammeter, replace as required. **Paragraph F of Section III, page 41**
	Open circuit – ammeter to timer	Disconnect wire harness at timer and check voltage from timer power pin to ground. If no voltage, locate and correct open circuit.
	Open circuit – timer to both brush assemblies	Disconnect wire harness at brush assembly and check voltage to ground from appropriate timer pins or timer wire harness leads. If low or no voltage, locate and correct high resistance in timer wire harness or open circuit.
		Check continuity from appropriate timer pin or timer wire harness lead to ground. If high resistance indicated, check ground wire for breakage and ground connections for correctness and tightness. Correct as required.
	Open circuit to de-icer, de-icer wire harness or slip ring leads	Check de-icer wire harness leads for continuity. Ohmmeter needle should not flicker when leads are stretched or flexed. Replace as required. For long lead de-icers, disconnect de-icer leads and check resistance per ATA 30-60-07. If correct resistance, check for open circuit in slip ring leads. Repair or replace parts as required.
Ammeter shows normal current part of cycle, zero current rest of cycle	Open circuit between timer and brush assembly on one engine	Disconnect wire harness at brush assembly and check voltage to ground from appropriate timer pins or timer wire harness leads. If low or no voltage, locate and correct high resistance in timer wire harness or open circuit.

Trouble	Probable Cause	Remedy
Ammeter shows normal current part of cycle, zero current rest of cycle **(cont'd)**	Open circuit in de-icer or slip ring leads	Check continuity from appropriate timer pin or timer wire harness lead to ground. If high resistance indicated, check ground wire for breakage and ground connections for correctness and tightness. Correct as required.
	Faulty timer	Test timer per **Paragraph E, Section III, page 39**, and repair or replace.
Ammeter shows normal current part of cycle, low current rest of cycle	If dual element de-icers, inboard and outboard de-icer elements are heating in same phase (in series)	Locate and repair incorrect lead connections.
	Open circuit or high resistance in de-icer or slip ring leads	Check continuity from appropriate de-icer or wire harness lead to ground. If high resistance indicated, check ground wire for breakage and ground connections for correctness and tightness. Correct as required.
	High resistance in circuit with low current	Check alignment of brushes to slip rings per **Paragraph A4, Section III, page 35**, and correct as indicated. Check system wiring beginning at timer through to de-icers for loose or corroded connections or partially broken wiring. Correct as required.
Ammeter shows low current over entire cycle	Aircraft voltage low under normal operating conditions	Check voltage into switch.
	Faulty ammeter, switch or circuit breaker	Check voltage to and from ammeter, switch and circuit breaker. Test ammeter per **Paragraph F, Section III, page 41**. If output voltage low and input voltage correct, replace defective component.
	High contact resistance in timer	Test timer per **Paragraph E, Section III, page 39**, and repair or replace as required.
	With dual element de-icers, one de-icer element (or wiring connection) in each cycle is open	Perform heat test on each de-icer per **Paragraph A4, Section III, page 35.** Replace defective de-icers or remedy incorrect wiring connections.

Trouble	Probable Cause	Remedy
Ammeter shows excess current over entire cycle	Power lead shorted to ground	Check power leads from ammeter to timer and power leads to de-icers for evidence of damage or arcing. With system OFF and timer wire harness disconnected, check insulation resistance to ground from timer wire harness pin B. Disconnect timer wire harness at brush assembly and repeat insulation resistance check for applicable pins. If ground indicated, locate and correct short.
Ammeter shows excess current over entire cycle	Ammeter faulty	Test ammeter per **Paragraph F, Section III, page 41.**
Ammeter shows normal current part of cycle, excess current rest of cycle	Short to ground or between adjacent circuits, or between timer to brush assembly	Disconnect leads at brush assembly and timer. Check insulation resistance from power leads to ground and between adjacent circuits. If ground or short circuit indicated, locate and correct.
	Short circuit to prop or between two adjacent slip ring to de-icer circuits	Isolate brush assembly and check insulation resistance from one slip ring to bare prop. Reading should be at least .5 megohms after 1 minute. If resistance reading not correct, disconnect slip ring leads one set at a time to trace short circuit. If correct resistance reading , disconnect slip ring leads and check insulation resistance between slip rings. Reading should be at least .5 megohm after 1 minute.. If resistance reading not correct, clean slip ring thoroughly and check resistance again. Replace slip ring as required.
	Timer faulty	Test timer per **Paragraph E, Section III, page 39**, and repair or replace.
Ammeter does not “flicker” between output intervals. **(See Table 1 for applicability.)**	Timer ground open; timer not cycling	Disconnect timer harness and check ground connection with ohmmeter from appropriate pin shown in **Table 3, page 40**.
	Timer contacts welded together (caused by short circuit in electrical system)	Test timer per **Paragraph E, Section III, page 39**, insuring that short circuit causing original failure located and corrected.

Trouble	Probable Cause	Remedy
Ammeter flickers between output intervals. **(See Table 3, page 40, for applicability.)**	Loose connection between aircraft power supply and timer input	Trace wiring from power source to timer input. Insure all electrical contacts in circuit are sound.
	Loose or poor timer to de-icer connection.	If trouble occurs during only part of cycle, determine affected de-icers and check for rough or dirty slip rings causing brush to skip. Check affected circuits for loose or poor connections. If all de-icers on one prop affected, check ground circuit.
	Timer cycles erratically	Test timer per **Paragraph E, Section III, page 39**, and repair or replace.
Radio noise or interference with de-icing system ON	Brushes arcing	Check brush alignment per **Paragraph N, Section II, page 31.** Check for dirty or rough slip rings and clean, machine or replace as required. Check slip ring run-out per **Paragraph L5, Section II, page 30.**
	Loose connection	If trouble occurs during only part of the cycle, determine affected de-icers and check for rough or dirty slip rings causing brush to skip. Check affected circuits for poor connections. If all de-icers on one prop affected, check ground circuit. Trace wiring from power source to timer input. Insure all electrical in circuit are sound.
	Fault switch or circuit breaker	Place jumper wire across switch or circuit breaker. If radio noise disappears replace switch or circuit breaker.
	Wiring too close to radio equipment or associated wiring	Relocate de-icing system wiring at least 8” from radio equipment and wiring.
Cycling sequence not correct	Crossed connections between timer and de-icers	Check system wiring against circuit diagram.
	Faulty timer	Test timer per **Paragraph E, Section III, page 39**, and repair or replace as required.
Rapid brush wear or frequent breakage	Brush assembly out of alignment	Check brush alignment per **Paragraph N, Section II, page 31.**
	Slip ring wobbles	Check slip ring run-out per **Paragraph L5, Section II, page 30.**
	Rough slip rings	Machine slip ring per **Paragraph C, Section III, page 36.**

J. Repair Procedures

1. Electrical Repairs

   a. For soldering, use Kester “Resin Five” core colder, 0.062 strand, No. 66 or equivalent. Do not allow solder flow (wicking) to extend onto wire that is flexed.
   b. Use manufacturer recommended crimping tool that crimps both sides of terminal to avoid loosening insulation when attaching terminals to wire. Make sure terminal is crimped to bare wire. When wire is too short to repair, replace with same gauge and quality.
   c. Straighten bent receptacle pins with long needle nose pliers. When work hardening leaves pin brittle, replace receptacle. Minor damage to receptacle threads can be repaired; major damage requires replacement. Check insulation resistance with Megger between pins to make sure receptacle is not damaged. Resistance should be at least 0.5 megohm after one minute at 500 VDC.
   d. Redress wiring when chafed or worn. When damage is minor, wrap wiring well with insulating tape and cover with vinyl tubing. When damage is major, replace wiring with same gauge and quality.

2. Mechanical Repairs

   a. Use safety wire at timer, wire harnesses, brush assembly, slip ring, de-icer lead clip and other locations as specified in AMM. Tighten mounting hardware and electrical connections firmly or according to torque value given for each. Avoid stripping threads with excess force. Always use new locknuts during assembly.

Note: When component is not manufactured by Goodrich, check with component or aircraft manufacturer for repair procedures and replacement parts.

3. Switch, Circuit Breaker, Ammeter (Optional), Timer Repairs

   a. Switch, circuit breaker, ammeter, shunt and timer **are not field repairable**. If a Goodrich component is suspected of malfunction, return to Goodrich authorized repair facility for evaluation, or replace with an identical part as listed in Goodrich Replacement Parts List or AMM Parts List. Use same (or equivalent to original) mounting and electrical connection hardware to install replacement component.

4. Brush Assembly Repairs - See Goodrich ATA 30-60-01.

5. Slip Ring Repairs

   a. A structurally sound slip ring with roughened or damaged surfaces can be machined to restore serviceability. Check slip ring before machining to determine if sufficient slip ring surface remains. See **Table 2, page 38**, for minimum dimensions and **Paragraph C6, Section II, page 36,** for machining instructions. Do not machine a slip ring worn at or below minimum dimensions.
   b. Some slip rings have studs that are brazed or welded to the assembly, and serve as electrical connection. Avoid side loading studs while working on assembly. Broken studs can be repaired only at the Goodrich manufacturing facility.
   c. When the brush alignment cannot be adjusted sufficiently per **Figures 39-41, page 32,** to ride fully on the copper rings, then the spinner bulkhead, the slip ring mounting holes, or the slip ring is not concentric. The non-concentric item must be replaced; there is no remedy.

d. When a slip ring lead wire is frayed or broken, repair or replace it with wire of equivalent length, gauge and quality. When a wire is broken inside the slip ring, there is no remedy. The slip ring must be replaced.

e. When a wire breaks at a stud, replace it as follows: Place the assembly on a heat sink; the temperature of the assembly should not rise above 175°F anywhere except at the stud. Clean out the hole in the stud; remove the broken wire and solder in a new wire of equivalent length, gauge and quality. Check continuity with an ohmmeter after wire replacement.

f. A slip ring which is open electrically, cracked or damaged structurally, or with a badly damaged surface must be replaced. Align the new assembly per **Paragraph L5, Section II, page 30.**

R 6. De-Icer Repair/Replacement

a. Prop de-icer repair is limited to replacement erosion tape (if applicable) and refurbishment of edge sealer.

b. Goodrich propeller de-icers are not repairable. De-icer surface damage, such as punctures, cuts, scuffs, erosion, that exposes the wire or etched element is grounds for replacement, as addition of repair material could affect de-icer performance.

c. When testing or inspection shows the need to replace a de-icer, replace the de-icer per Goodrich ATA 30-60-07, paying particular attention to the weight and balance instructions.