

Engine Overhaul Fundamentals, Part Six: ELECTRICAL SYSTEM



Last month, DENNIS WOLTER discussed common renovation errors, like use of improper hardware, and took an in-depth look at engine baffles. This month, he describes the correct methods for cleaning, repairing and securing electrical system components.

Let's move forward with the owner-performed work needed to create a like-new engine bay. One system under the cowling that noticeably deteriorates over time is the electrical system.

Exposure to heat, moisture, cold, vibration and weather causes corrosion on terminals, relays, voltage control units, rubber grommets, wire insulation and other electrical components. Corrosion results in possible reduction of current flow.

Securing, upgrading and protecting the wiring under the cowling and in the rest of the airframe is thoroughly covered in the airplane maintenance "how-to" guide, otherwise known as FAA Advisory

Circular 43.13-1B. It's available as a free download from the FAA. The document can also be purchased in printed form from Sporty's Pilot Shop. (See *Resources for more information.* —Ed.)

I refer here to Chapter 11, Sections 8 through 15. This beautifully-illustrated manual thoroughly shows how things should be done. (Remember, owners are only allowed to do preventive maintenance tasks. Other maintenance, including many things covered by 43.13-1B, must be performed by an appropriately-certificated maintenance technician. —Ed.)

The examples I will discuss in this article represent some of the most common electrical system problems Air Mod has seen over the years.

Inspection, repair, corrosion prevention and proper reassembly

Every connection point, plug, wire terminal and relay should be inspected, cleaned and sprayed using a good contact

cleaner and lubricant. We use a contact cleaner sold under the name of QD Electronic Cleaner that can be found at auto parts stores and other retailers.

Any wiring that shows evidence of deteriorated insulation should be replaced with Mil-Spec Teflon insulated wire or covered with heat-shrink tubing.

Don't forget to check the condition of the protective terminal silicone rubber boot-type covers. New covers are available from Piper Flyer supporter Aircraft Spruce. See an example of heat-shrink-covered wires and silicone rubber boots in the opening photo.

Worn or damaged wire terminals should be replaced with aircraft-quality crimp connectors that are installed with the correct crimping tool.

As an added step in corrosion prevention, I like to solder all crimp-on terminal connectors that are under the cowling or in retractable landing gear wells. Be careful not to heat damage the

Pay very close attention to any place where a wire, hose or cable passes through the firewall.

protective plastic sleeve that is part of these terminal connectors.

If the electrical terminal stud is corroded or rusted, clean the stud and terminal lug thoroughly with a stainless steel wire brush. Replace the old mounting nut, flat washer and split-type lock washer with new components.

A good example of how helpful AC 43.13-1B can be is Table 11-16 in Chapter 11, an illustration that shows the correct assembly of the above-mentioned hardware. When building a new instrument panel or installing new engine-related wiring, we often find incorrect hardware or poor-quality connectors behind instrument panels and cowlings.

Simple things can cause complex problems. Use aviation-grade connectors and partner with your maintenance technician for advice on the correct products, tools and procedures for electrical work.

Generator to alternator upgrades

Many of us flying 30- to 50-year-old airplanes have had a low-output generator to high-output alternator conversion. Ask your maintenance technician to verify that the alternator output wiring and ammeter (amp meter) are capable of handling the additional electrical load.

A lot of airplanes manufactured in the 1950s and 1960s left the factory with 25-amp generators. The wiring and ammeters mated to these low-output generators must be upgraded to higher-rated components as part of an alternator conversion. For instance, it's necessary to use heavier-gauge output wires and higher-capacity 75- to 100-amp ammeters.

Hooking up a 75-amp alternator to an old 25-amp charging system is like hooking a garden hose up to a fire hydrant! I was once delivering a 1950s aircraft to a paint shop and had a total electrical failure.

After manually extending the gear and landing at the nearest airport, I discovered that the terminals connecting the alternator output wire to the ammeter were totally fried. A 25-amp ammeter trying to carry 75 amps of alternator output—not good!

Securing electrical wiring

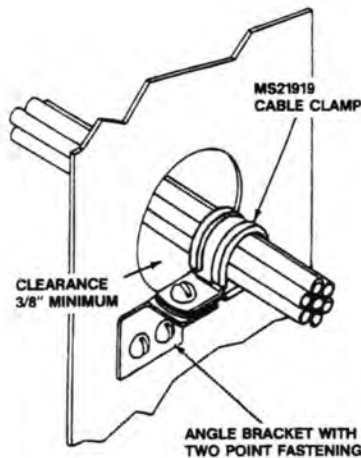
Securing electrical wiring can be done in two basic ways. Large-capacity wires such as starter feed wires, generator or alternator output wires and large multi-conductor harnesses should be secured with rubber-insulated aluminum or steel Adel clamps and machine screws. The illustration in AC 43.13-1B, Chapter 11, Figure 11-14 shows exactly how to do this correctly.



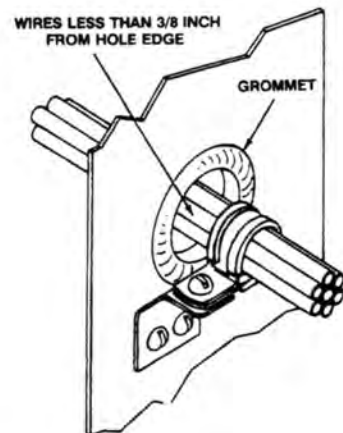
FAA Advisory Circular 43.13-1B, the airplane maintenance bible.



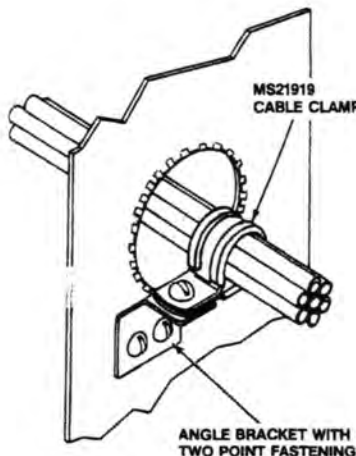
This severely-rusted relay terminal was hidden under a silicone rubber boot.



A. CUSHION CLAMP AT BULKHEAD HOLE.



B. CUSHION CLAMP AT BULKHEAD HOLE WITH MS35489 GROMMET.



C. CUSHION CLAMP AT BULKHEAD HOLE WITH MS21266 GROMMET.

"Clamping at a bulkhead hole" is an example of the excellent guidance AC 43.13-1B provides.

Small wires can be secured with nylon cable ties. I highly recommend using only cable ties that have a small spring steel locking tab molded into the head of the cable ties. We use cable ties sold under the brand name of Ty-Rap available on the internet.

If you are securing two wires that cross at a high angle of incidence, use wire ties that are secured to one another. This method will eliminate abrasion of the insulation of those two crossing wires. I also employ this two-wire-tie method when securing any wiring to the metal airframe or engine mount.



A close-up of the metal locking tab built into high-quality wire ties.

Just passing through

It's also important to check the condition of rubber grommets that are installed where wires, hoses and hard lines pass through baffles and firewalls. It's not uncommon to find a deteriorated grommet that is no longer keeping an important wire or hose from rubbing against bare metal. Old rubber is often bad rubber.

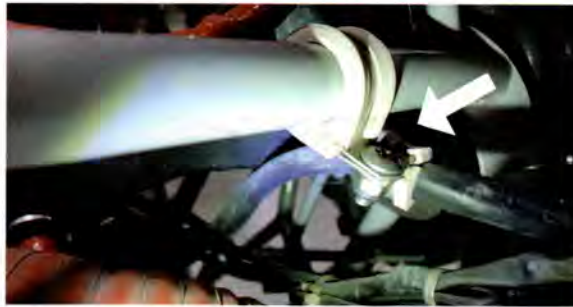
Pay very close attention to any place where a wire, hose or cable passes through the firewall. Any firewall pass-through must be of such a design that it can isolate the aircraft's cabin from a fire in the engine compartment. "Creative" ways of passing wires and hoses through the firewall are found in some older airplanes. A rubber grommet or silicone seal will not stop a fire from getting through the firewall.

Many airframe manufacturers originally installed engineered metal firewall pass-throughs that protect and seal the wire or hose as it passes through the firewall. This type of firewall pass-through is available from Aircraft Spruce. *(Another PFA supporter, Wag-Aero, carries a stainless steel firewall shield. —Ed.)* This is also a topic to discuss with your maintenance technician.

Ducts

While you're examining electrical components, it's a good time to inspect the large- and small-diameter flexible tubes you've no doubt encountered under the cowling. Aircraft engine bays are filled with duct hoses that are an integral part of cabin heat, fresh air, carburetor heat and engine induction air delivery systems. Inspect these large- and small-diameter flexible tubes for any sign of tearing and abrasion. Don't overlook the associated mounting flanges and clamps.

A common complaint we are asked to correct when installing a new interior is how cold the cabin can be in cold weather. Worn-out flexible ducting is often the



Double Adel clamps and a 10-32 machine screw and nut secure a large wire to the engine mount.



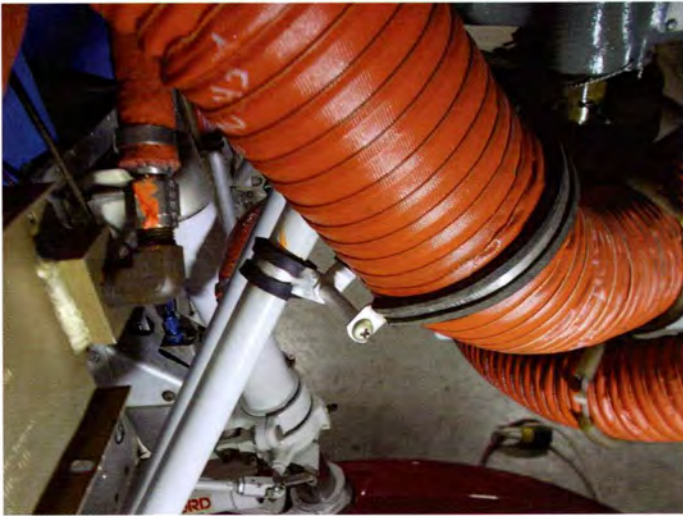
A simple rubber grommet is not the correct method for running a wire through a bulkhead.



A metal flanged pass-through correctly installed at the factory. This engineered firewall pass-through will actually protect the cabin from smoke and hot gases of an engine fire.



Deteriorated neoprene-impregnated fiberglass duct hose; replace this stuff with better quality orange silicone SCAT duct hose.



Two rubber-cushioned Adel clamps secure a large-diameter hose to an engine mount.



Severe battery acid damage in the lower corner of an aluminum battery box.



A stainless steel battery box with a welded corner repair, ready to be sealed with epoxy seal material secured with rivets.



Acid-neutralizing baking soda and acid-proof battery box paint can help in cleaning an older battery box.



Sloppy use of high-temperature silicone covering an unused, riveted-in-place firewall patch.

culprit here. At Air Mod, we install only orange SCAT silicone ducting, available from Aircraft Spruce (as well as PFA supporter Chief Aircraft and others —Ed.). We use quality stainless steel screw clamps when fixing these systems.

Often, the damage to these SCAT hoses is caused by poor routing and clamping that allows the hose to get too close to the exhaust system or allows it to rub against a hard object in the engine bay. The best way to secure the often-large hoses is to use the correct size rubber insulated Adel clamp and machine screws. Nylon wire ties are not the best choice for this job.

(For more about proper clamp use on ducting and other flexible hose material, see "Engine Overhaul Fundamentals, Part Five" in the May issue of Piper Flyer. —Ed.)

Battery box rehab

Don't overlook the battery box. Years of housing unsealed lead-acid batteries can cause aluminum battery boxes to badly corrode. Some boxes will have places where the acid has eaten its way through the aluminum, allowing acid to escape the box and corrode the firewall and other often-critical components. Another issue is that, over the years, multiple layers of acid-proof battery box paint can be layered on to the battery box.

The first step in battery box rehab is to remove all that old paint. Use heat and plastic scrapers, followed with a thorough cleaning with red Scotch-Brite pads and lacquer thinner. Next, mix a strong solution of baking soda and hot water and clean all inner and outer surfaces of the box with the red Scotch-Brite. (For a more complete list of tools and supplies, see "Engine Overhaul Fundamentals, Part Four" in the April issue of Piper Flyer. —Ed.)

The baking soda does a great job of neutralizing any battery acid residue. If the battery box is full of holes or a corner is corroded through, remove the box and have a professional welder make a repair.

Once the box is thoroughly cleaned and repaired, refinish it with Randolph 345 acid-proof battery box paint available from Aircraft Spruce (and other PFA supporters —Ed.). Don't forget to check the old rubber grommets that prevent the battery terminals from coming in contact with the metal box.

If the battery box is in very poor shape, it may be more cost-effective to bite the bullet and buy a new battery box. If possible, check to see if there is an FAA-approved stainless steel replacement box for your aircraft. (Bogert Aviation is one

choice; see Resources. —Ed.) With the availability of sealed modern batteries, future issues with battery boxes should become ancient history. (PFA supporters Concorde Battery, EnerSys (Hawker) and Teledyne Battery Products (Gill) offer a variety of sealed batteries. —Ed.)

Be careful with silicone sealants

I'm going to end this article with one of my biggest pet peeves: silicone seal. I recognize that silicone is a great way of preventing abrasion and sealing small gaps in baffles. The issue I have is the sloppy ways in which it is usually applied.

I get that one's index finger is often the application tool of choice, but don't forget about masking tape. Using both of these tools to neatly apply a controlled layer of silicone caulk will do a much better job of creating the desired seal, will look good and also prevents wasted silicone caulk.

It really gets to me when I see a beautifully-detailed engine, painted engine mount and new baffles, and then take a look at sloppily-applied bright orange, dabbed-on silicone seal. The devil is in the details!

In my next article, we will wrap up this engine stuff by outlining the details your licensed maintenance technician will be attending to as he or she brings your overhaul project to its like-new conclusion. Until then, fly safe! PF

IMPORTANT: This article describes work that may need to be performed/supervised by a certificated aviation maintenance technician. Know your FAR/AIM and check with your mechanic before starting any work.

Industrial designer and aviation enthusiast Dennis Wolter is well-known for giving countless seminars and contributing his expertise about all phases of aircraft renovation in various publications. Wolter founded Air Mod in 1973 in order to offer private aircraft owners the same professional, high-quality work then only offered to corporate jet operators. Send questions or comments to editor@Piperflyer.org.

RESOURCES >>>>

QD ELECTRONIC CLEANER
CRC Industries
crcindustries.com/products/

qd-174-electronic-cleaner-11-wt-oz-05103.html

TY-RAP CABLE TIES

Thomas & Betts
tnb.com/pub/en/brands/ty-rap

PARTS AND SUPPLIES (SCAT tubing, firewall pass-throughs, acid-proof paint, etc.) – PFA SUPPORTERS

Aircraft Spruce and Specialty Co.
aircraftspruce.com

Chief Aircraft
chiefaircraft.com

Univair Aircraft Corp.
univair.com

Wag-Aero Inc.
wagaero.com

AIRCRAFT BATTERIES
– PFA SUPPORTERS

Concorde Battery
concorde.com

EnerSys (Hawker)
enersys.com

Teledyne Battery Products (Gill)
gillbatteries.com

AIRCRAFT BATTERY BOXES

Bogert Aviation
bogertaviation.com

FURTHER READING

AC 43.13-1B, "Acceptable Methods, Techniques and Practices – Aircraft Inspection and Repair" (electronic file download)
faa.gov/documentLibrary/media/Advisory_Circular/AC_43.13-1B_w-chg1.pdf

AC 43.13-1B, "Acceptable Methods, Techniques and Practices – Aircraft Inspection and Repair" (hard copy)
Sporty's Pilot Shop
sportys.com/pilotshop/aircraft-inspection-repair-alterations.html