Nipon-Denso Alternator Modifications

The following paper was submitted to the AeroElectric.com for consideration of a technique that reconfigures an automotive alternator to conform with traditional aircraft philosophy for alternator control and over voltage protection. It is offered to the OBAM aviation community in support of our mission to be a gathering place for the best we know how to do.

This paper has not been evaluated in detail for accuracy nor will the document be maintained by the AeroElectric Connection. We'll be pleased to publish feedback based on field experiences with this task.

Bob . . .

ND Denso Alternator Modification

Here is a way to modify an internally-regulated ND, or Denso alternator such that it cannot fail in a runaway condition and the pilot always has complete control to turn it off. In stock configuration, there exists a failure mode in which the main switching transistor in the regulator COULD fail "on", and thereby create a voltage runaway condition. This is probably an exceedingly rare failure mode, but possible nonetheless. In the Denso alternator, the main switching transistor in the regulator completes the field rotor winding circuit to ground. The other end of the field winding is connected to the B-plus output terminal of the alternator. If that transistor were to fail closed, the output of the alternator would uncontrollably increase in a runaway condition. The following modification removes the always-on B-plus feed of the field coil and replaces it with the "IG" terminal, which is typically switched and fused 5A in the airplane wiring. With this modification, the "IG" feed will carry all of the field current instead of only supplying a signal to turn on the regulator. We'll add a "crowbar" device to positively shut off the alternator automatically, just as a certain well-regarded airplane alternator vendor does it.

First, start with an alternator that was originally intended for a Honda 4-cylinder automobile, from the 1988-1999 vintage. These engines rotate "backwards" compared to most all other automotive engines and therefore have the correct internal cooling fans for Lycoming usage. That same well-regarded vendor would have you believe they use custom rotor fans, but they're simply Honda units. If you're sourcing one of these from a wrecking yard, be certain that the donor car has its engine-driven accessories on the LH, or driver's side. Post-2000 Hondas were redesigned and have the accessories on the RH side, which we don't want. Some of these Honda alternators have a 4-wire regulator connector. These should be able to be modified as well, but I have not tested them to be sure. I used a regulator for a 1990 Toyota Camry which is a 3-wire unit. While you're in the junk yard, snip off the input connector from the car's wiring harness, leaving enough slack to splice it into your airplane's harness.

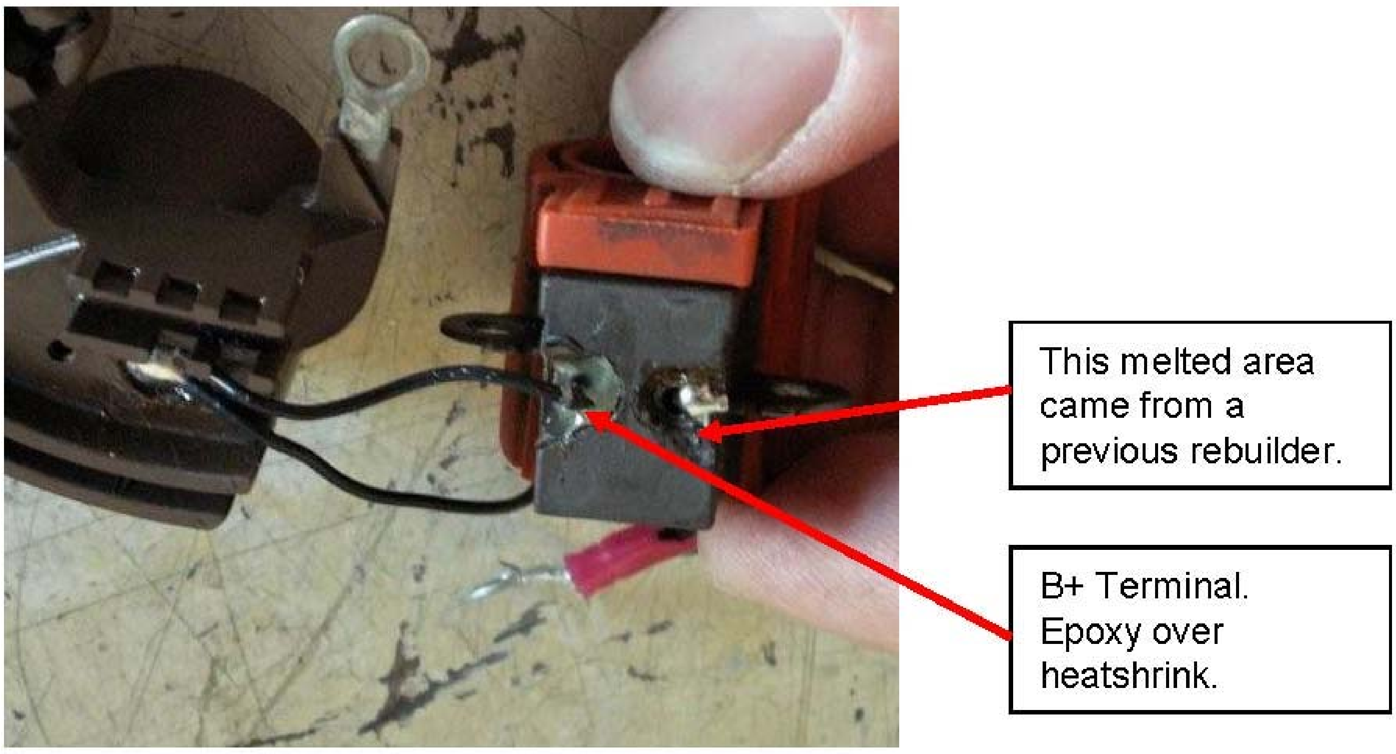
Wire your alternator harness as shown here from a Toyota training manual I found on the web, except that we'll use a 5A breaker instead of the fuse shown (go to www.autoshop101.com and search "charging system").

The indicator lamp is optional, but recommended.

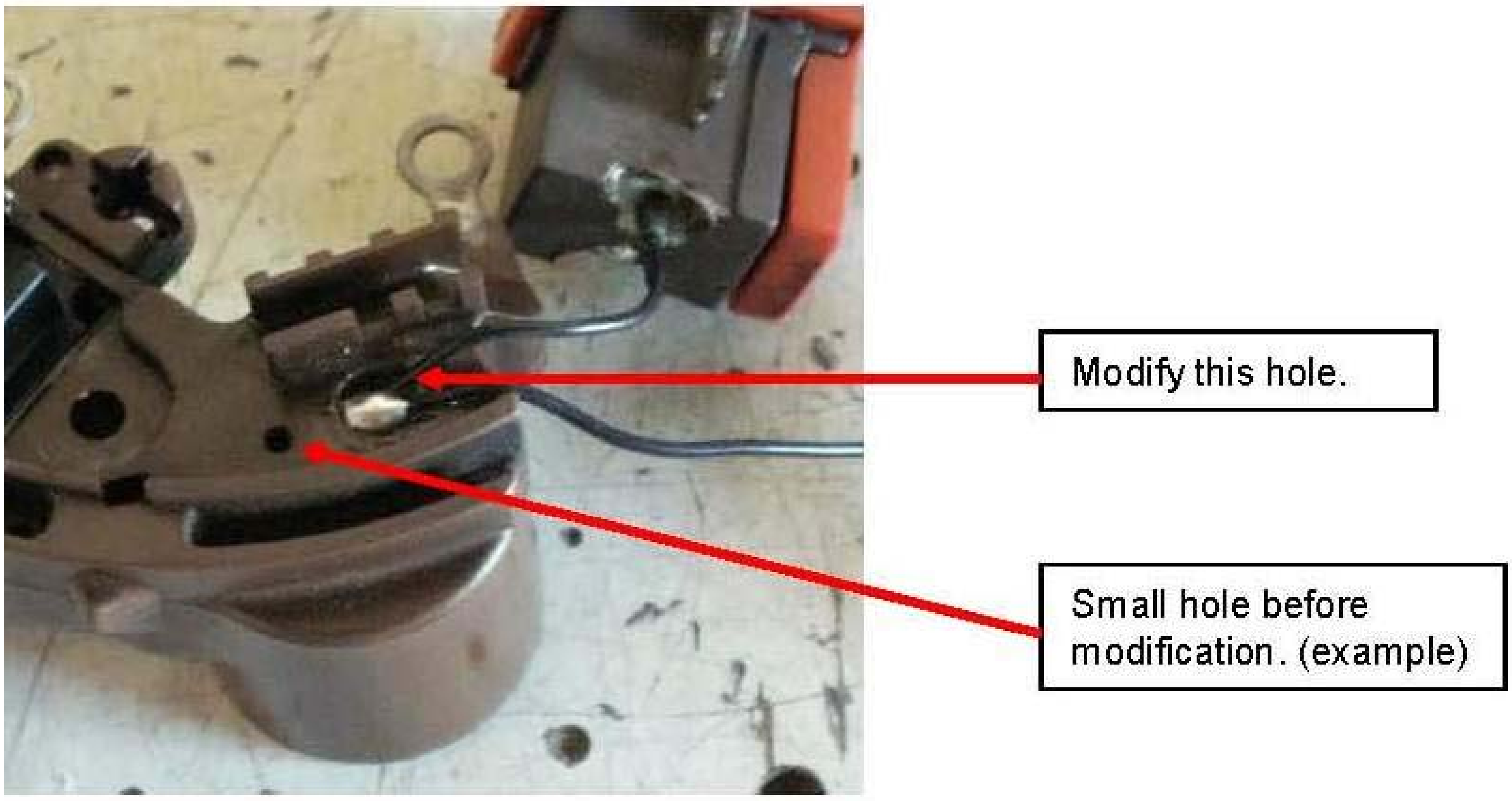
Disassemble the alternator and replace the bearings and brushes, if you're starting with a used unit.

Unsolder the brush lead from the B+ side of the brush holder-- with the terminal end of the brush holder facing you and the silicone dust cover on top, it's the left-side terminal. Use solder wick or equivalent to remove excess solder.

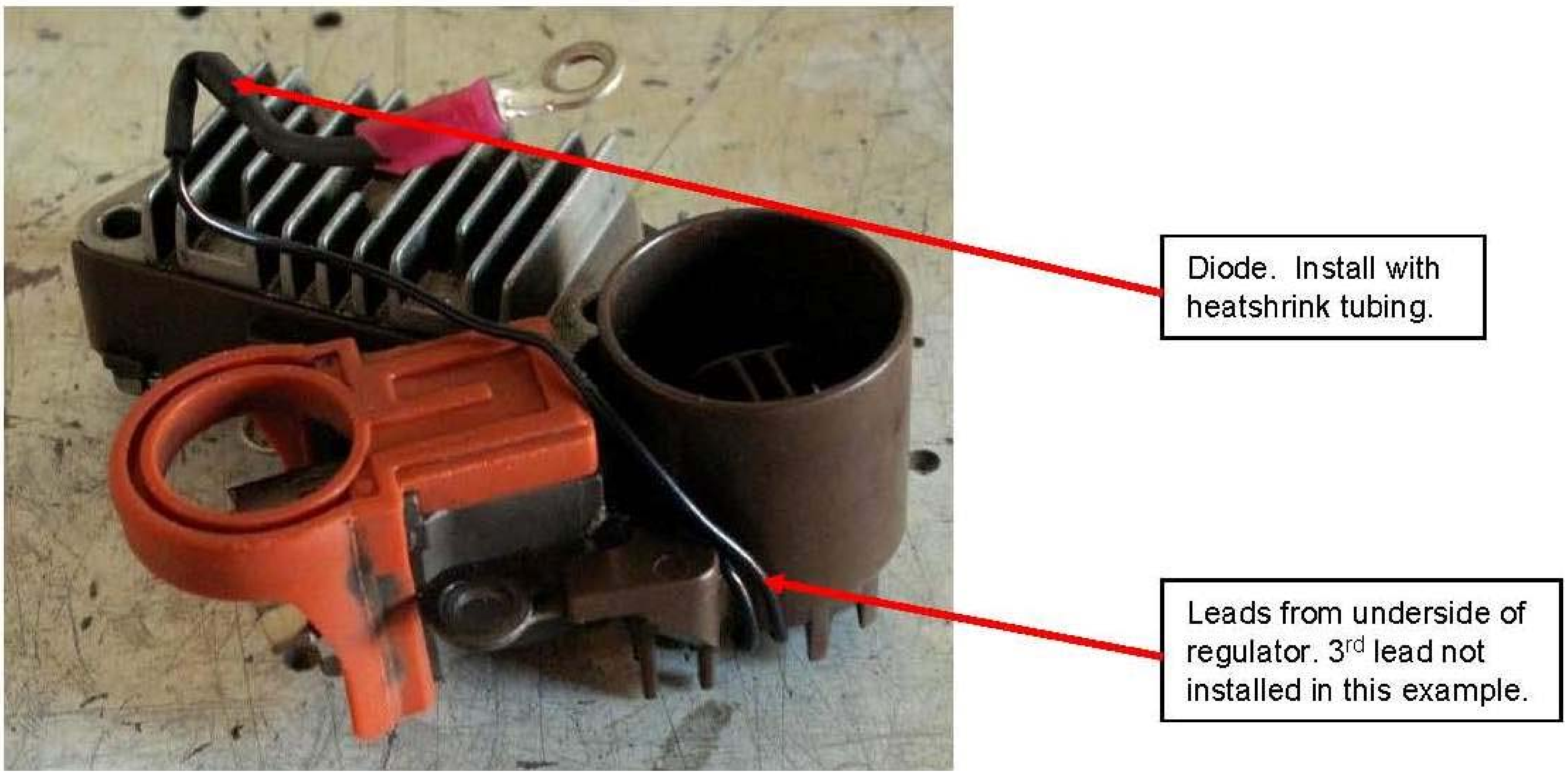
Ream hole where brush lead was attached to #35. Cut off 1/4" from brush lead and solder a length of 22-ga tefzel wire to end of lead. Apply heatshrink tubing over solder joint. Reassemble brush into holder with spring. Epoxy new lead over heatshrink area into end of brush holder:



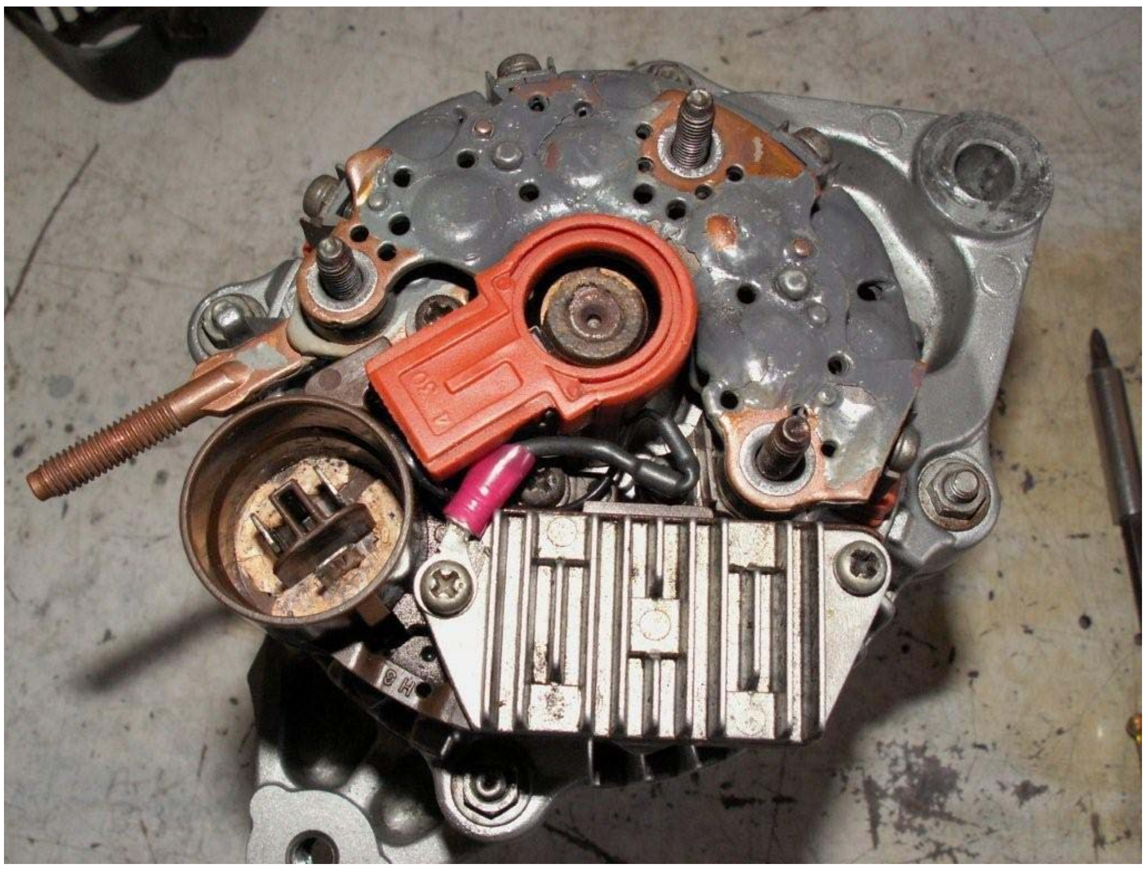
On the underside of the regulator, notice the three small holes under the input connector. Using the hole closest to the "IG" terminal as a pilot hole, very carefully drill by hand into the plastic of the regulator body down to the brass terminal. Open the hole to 3/16" diameter and then use a flat-bottom end mill or router bit and create a flat area around the terminal big enough to solder to:



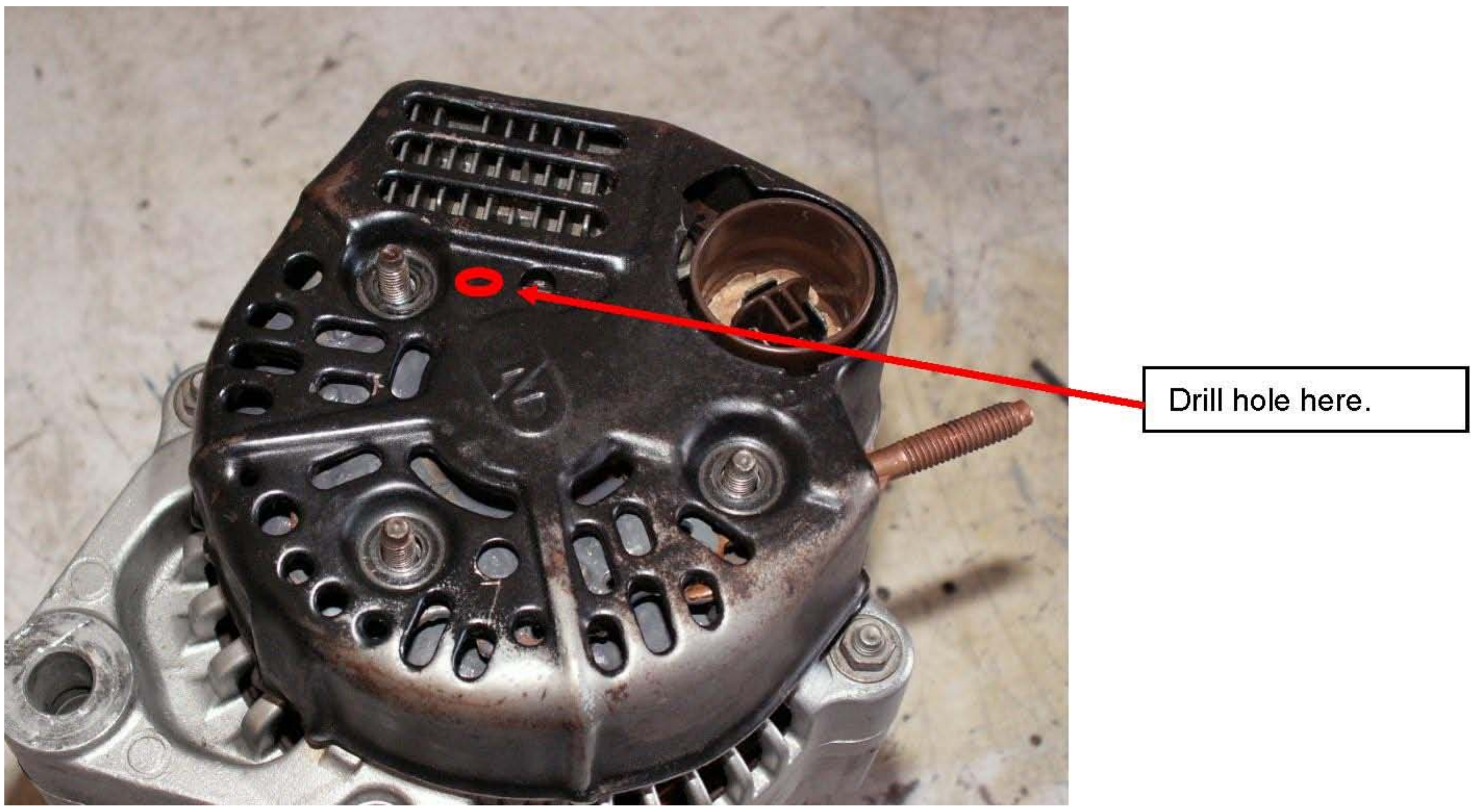
Mock-up assemble brush holder to regulator and route new brush feed lead to underside of regulator where modified previously. Solder new brush feed lead along with two more 22-ga leads (three total) to uncovered terminal.



Route all three leads upward and reassemble regulator and brush holder into alternator. Solder one of the leads to the cathode of a 1A diode. Solder a 2" length of wire to the anode of diode and heatshrink. Crimp #8 ring terminal to anode end of diode lead and attach to a regulator hold-down screw. This diode will prevent pulse from collapsing field coil from back-feeding into regulator if/when 5A field breaker is pulled for testing with engine running.



Hold rear cover over alternator and determine where to drill hole for crowbar lead pass-through:



Drill hole and deburr and install rubber grommet.

Route remaining lead through cover. Reassemble cover. Connect B&C crowbar (+) lead and crimp a ring terminal to remaining crowbar lead and bolt to one of the back cover nuts. Glue the crowbar to the cover with RTV.

Using a crowbar at this location will mitigate the current surge that will occur if the crowbar trips due to the typically 5-plus feet of 20-ga wire in the loop with the 5A breaker. This potential surge was a big sticking point with some rather vociferous characters on the web who claimed that a 5A breaker wasn't designed for short circuits... Whichever way you think, this install ought to keep them at bay.