

NTSB File No. CEN19LA002

Alternator Exam Notes

Accident

Accident Date: January 31, 2019
Location: Katy, TX
Aircraft: Mooney M20K, N56359
Engine: Continental TSIO-360

Examination Location and Participants

Location: Hartzell Engine Technologies (HET) in Montgomery, AL
Date: March 5, 2019
Participants: Les Doud – HET Air Safety Investigator
Courtney Liedler – NTSB Air Safety Investigator – Central Region
Anna Williams – FAA Birmingham FSDO, HET Principal Inspector
Corey Broussard – HET Electro-Mechanical Engineer
Brady Edwards – HET Mechanical Engineer

Alternator and Voltage Regulator Description

The ALX-9525BR alternator is a gear-driven, 12V, 70 amp, 3-phase “Y” armature, DC-output alternator.

Alternator P/N: Kelly Aerospace ALX-9525BR
Alternator S/N: GO11015

The voltage regulator used on the accident aircraft was a Zeftronics “Alternator Controller.” The Zeftronics voltage regulator is a solid-state unit with a 14V regulated voltage output and 16V over-voltage limit. It is unknown if the unit contains any under-voltage or over-current protection.

Alternator Controller P/N: Zeftronics R15300
Alternator Controller S/N: R0G031

As Received Condition

The alternator was presented for examination as shown in Photos #1 and #2. Functional testing on a test bench was not possible due to impact damage. The alternator case (both slip ring end and drive end) was fractured and stator/armature ring was bent and distorted. The case thru-bolts were bent and the threaded sections were fracture-separated. The alternator was packed with dried mud/dirt. The mounting gasket appeared intact and undamaged. The slip ring end case assembly where the terminals are located was dented with some corrosion. The terminals did not display

any thermal distress. The drive coupling was intact with nut and cotter pin in place. The rotor could not be rotated by hand force.

The alternator control unit was intact but the housing was bent/dented as shown in Photo #3. The wires and connector appeared intact but the harness insulation/sheathing was torn in two locations.

Examination Findings

1. The alternator coupling was intact on the shaft with the nut secure and cotter pin present (Photo #4). The coupling nut breakaway torque was measured to be 20 in-lbs. vs. an installation torque specification of 175-200 in-lbs. The rotor shaft appeared bent but intact (Photo #5) with the Woodruff key intact and undamaged. The coupling bore and key slot was clean and undamaged (Photo #6).
2. The brush holder was displaced and fractured (Photo #10). The brushes were intact but had some impact damage (Photo #7). The brush wear limit line was visible and the wear pattern was smooth indicating proper seating on the slip ring for both brushes.
3. The slip rings appeared intact and undamaged with normal wear patterns (Photo #8).
4. Gaps between the stator assembly and rotor assembly were packed with dry mud/dirt, and the two were jammed together by impact forces (Photo #9) and had to be forcibly pressed apart in an arbor press.
5. Rectifier diode continuity and polarity checked Ok and the diode potting showed no signs of thermal distress (Photo #10).

Diode Drop	D1	D2	D3
Positive	0.49	0.50	0.52
Negative	0.52	0.53	0.53

6. Rotor/field coil continuity was confirmed with a resistance of 4.3 Ohms. Some rotor cooling fan fins were bent.
7. Bearings were clean with no sign of thermal distress or abnormal wear on the bearing races or rotor bearing surfaces. The drive end bearing was difficult to turn by finger force and felt like mud and/or water intrusion damaged the bearing post-impact. The slip ring end bearing moved freely by finger force. The bearing seals were in good condition and pliable.
8. The stator/armature coils were tested using the Baker Tester (Photo #13). The stator/armature coil insulation resistance test detected some leakage between two stator coils but there was no evidence of high temperatures indicative of leakage/arcing/short during operation. It was concluded the impact damage to the stator (Photo #11) pressed some stator wires together enough to compromise the insulating varnish.
9. Some stator wires showed slight black discoloration (Photo #12). This discoloration was at the slip ring end and attributed to brush dust. There was no evidence of thermal distress on any other part of the stator coils.
10. The Alternator Controller was mounted to a test bench and wired into a mule alternator for functional testing (Photo #14). Initial tests indicated the controller was not functioning properly so the cover was removed for examination of the internal components (Photo #15). Although the dented/bent case appeared to be

impinging on the back of the circuit board, opening the cover indicated the controller chassis needed to be grounded to function properly. The controller was remounted to the test bench with an additional ground wire to the chassis and run again. The controller functioned properly with the additional ground wire. Voltage output was approximately 13.6V at 45 amp current draw (Photo #16).

Conclusions

The alternator examination found no discrepancies that would prevent or degrade normal operation prior to impact. All damage was due to high impact forces. The alternator controller functioned properly with slightly low (<14v) output voltage at current levels above approximately 40 amps.

Les Doud

Hartzell Engine Technologies. - Air Safety Investigator

O: [REDACTED]

C: [REDACTED]

Photo #1 – Alternator as-received



Photo #2 – Alternator terminal end as-received



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A close-up photograph of a mechanical component, possibly a pump or valve, showing a gear-like structure and a central shaft, heavily encrusted with brown, crystalline deposits. The component is mounted on a red base with some text visible, including "MP-15".

Photo #5 – Alternator drive shaft and Woodruff key



Photo #6 – Alternator coupling bore and key slot



Photo #7 – Alternator brushes

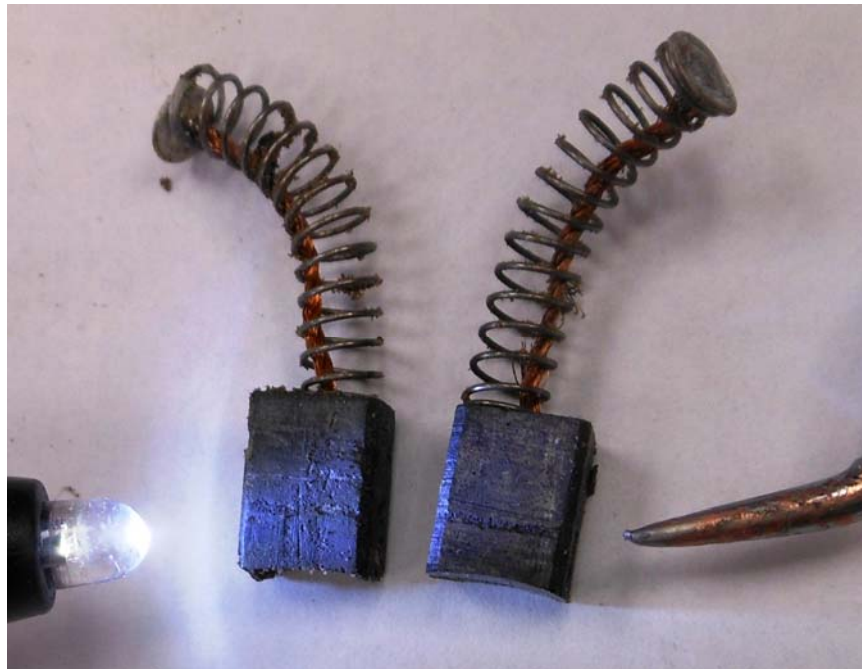


Photo #8 – Slip rings



Photo #9 – Rotor impingement on stator/armature assembly



Photo #10

Aft housing with rectifier diodes, brushes, brush holder and aft bearing as-opened



Photo #11 – Stator/armature damage from contact with rotor



Photo #12 – Some discoloration on stator/armature wires



Photo #13 – Stator/armature coil test



Photo #14 – Alternator Controller on test bench

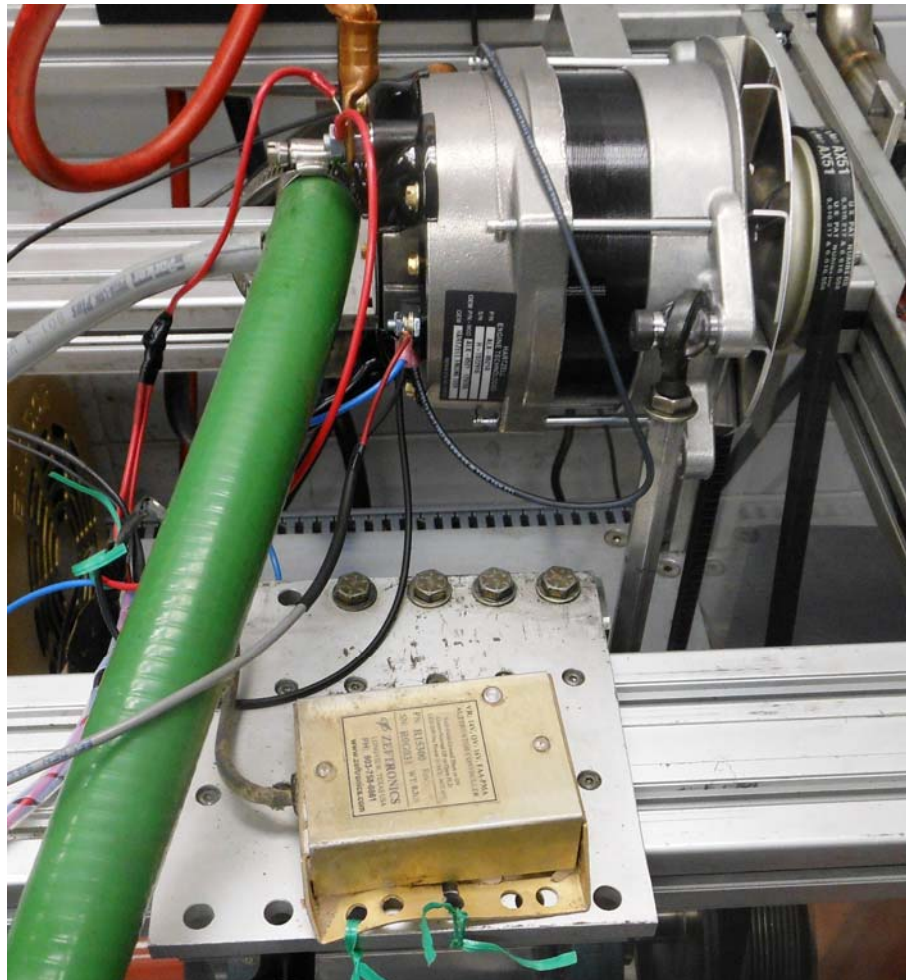


Photo #15 – Alternator Controller internal components



Photo #16 – Alternator Controller output voltage and current

