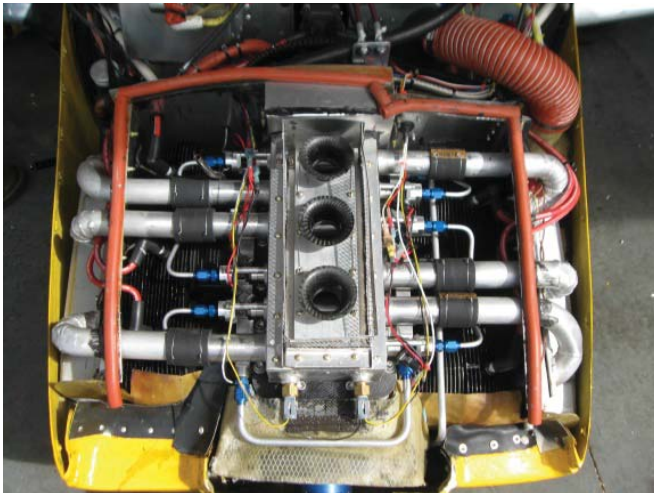


N610TT Engine inspection accomplished 9 May 2017 at the owner's hangar located at Columbia Gorge Airport, Dallesport, Washington. Inspection conducted by the owner and builder, Louis Ott with FAA airworthiness inspector Thomas Borland observing.

Introduction:

The engine is an air cooled, six cylinder automobile engine modified with dual Ford electronic ignition units and electronic fuel management. Engine output to the three bladed, composite propeller incorporates a specially designed thrust/support bearing assembly mated with the engine output shaft and drive hub. This arraignment is somewhat unique to this aircraft adaptation. A multi-toothed steel plate is mounted on the shaft aft of the propeller to provide crankshaft position indication to the electronic ignition through two electronic ignition pick-ups mounted to the front of the crank case. The two separate ignition units share the coil and spark plug leads that feed 1 spark plug per cylinder.

Six fuel injectors provide metered fuel into the common induction manifold. Fuel scheduling is accomplished by the electronic system in part by using inputs from sensors mounted in the forward end of the manifold. The custom sliding plate throttle system integral to the top of the manifold provides filtered air into the manifold through three air intakes. The fuel/air mixture is then introduced to the cylinders through conventional tubing.



The inspection of the engine was conducted while the engine remained mounted to the aircraft.



The engine compartment did not incur any notable damage from impact with the ground. All three of the propeller blades were broken off upon impact but the spinner unscathed.

Inspection:

Visual inspection of the engine shows it to be intact with no visible damage to it or the steel tube engine mount.

The crank shaft and internal integrity of the valve drive system did not appear damaged.

All six cylinders produced satisfactory compression when tested.

Spark plugs were clean and dry with some evidence of having run at a higher temperature.

Each cylinder was internally inspected with a boroscope by way of the spark plug hole with no damage noted.

Oil filter and magnetic drain plug showed no abnormal debris

The throttle control push/pull functioned normally.

The induction and exhaust systems were clear and free of obstructions.

Mixture settings are not retrievable in the field without the engine running because of a volatile memory in the electronic control.

The fuel gascolator had some small shiny metal contamination and fuel screen was clear.

Fuel pressure from the two electric, firewall mounded pumps checked normal. Delivery to the fuel injectors was verified but not measurable.

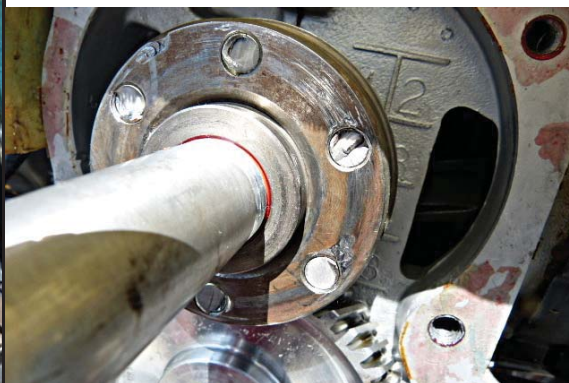
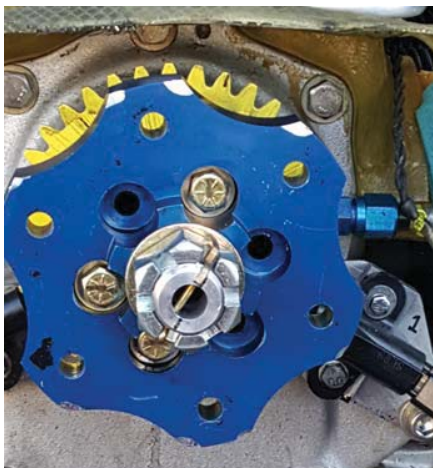
Fuel supply to the pumps was verified and unrestricted.

Engine ignition timing data was not retrievable electronically in the field because of a volatile memory in the electronic control. To determine ignition timing we utilized the conventional means of checking timing which uses an automotive type timing light and external markings on the engine. The ignition system seemed to function normally when tested showing timing to be approximately 10 degrees before top dead center which is consistent with the setting needed for starting.

All spark plugs fired with normal intensity during the timing test.

External timing marks at the rear of the engine were found to disagree with markings on the multi-toothed plate on the prop shaft that is used for the two electronic ignition magnetic pickups. The plate appears to have turned approximately 15-20 degrees counter clockwise.

The six bolts holding the prop hub to the drive hub were found to have all broken off. The large safety nut on the drive shaft was effectively the only thing holding the prop hub to the engine.





The bolts were visually examined and showed signs of stress fractures and cracking. There was some wear noted on the sides of these bolts as well

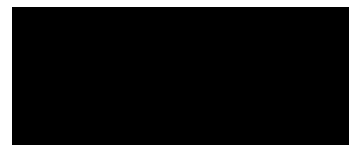
The bolts were industrial, grade 8 bolts, not aircraft hardware.

There was no evidence indicating that the bolts were improperly installed.

Review of the engine parameter analysis which is recorded in the electronic engine instrument system indicated that the engine was running normally, with normal exhaust gas temperature (EGT), Cylinder head temperature (CHT) and engine speeds for just over 5 minutes after takeoff. At that point those parameters changed abruptly with EGT rising dramatically with a slight drop in RPM. EGT mirrored RPM with throttle movements. Fuel pressure remained basically constant and adequate for continued operation of the engine. Cylinder head temps dropped and continued cooling for the remainder of the flight.

Inspector Borland's Opinion:

Failure of the bolts securing the propeller, and in turn the magnetic pickup target plate, caused a rotation of the plate to effectually retard the ignition timing of the engine. This resulted in significant loss of engine power. While continuing to operate in the diminished capacity the engine failed to perform as expected when called upon to correct the low altitude condition on approach to the runway.



Mr. Ott's notes on the bolts and opinion on probable cause of the power loss:

I don't believe those prop bolts broke when the prop hit the rocks as originally thought. They probably broke one at a time over the life of the installation. It is possible that I may have had 5 of them broken when I took off and all was good until the last one broke. At that point the timing instantly retarded by at least 15 degrees, the engine lost a few hundred RPM and the sound changed, and the EGT went up. This is all in line with retarded ignition timing.

I talked to the guy who helped me with the engine this evening. Those bolts are long, 4 or more inches, and the threads are at the aft end where they are threaded into the flywheel hub/cam gear. They go through the prop hub in holes that are not very tight. There is going to be flex in the fastening of the prop hub to the drive hub 4 or so inches out. The break happened right at the junction of the bolt shank and the threads. I doubt if the threads were rolled so that point is a weak point of the bolt and grade 8 isn't going to take any bending there. For some reason the bolts that normally are used for this weren't long enough so we elected to use these bolts instead. The engine does not have a torsional vibration dampener either. Whether a harmonic vibration happened to cause this is unknown. My plan was to measure torsional vibration at different RPMs shortly but hadn't gotten to it yet. If it weren't for that 1"dia "safety shaft" I'd have lost the prop and the hub.

When the prop struck the rocks, the prop hub may have moved again as well and whether the original problem had the timing retarded by 15 deg as we found it or more or less is unknown.

I looked at the bolts again and took some pictures. I checked the back side of the bolts in the flange. They project out from the drive hub about 1 thread. Still an eighth of an inch from bottoming on the cam gear. I think the break pattern on some of the bolts is that of a stress fracture and not simple shearing. The pattern shows the fracture starting at a point on the edge and progressing across to the other side where it fails. Some of the bolt ends are a bit polished looking too. Also, all the bolts show a wear pattern on the shank of the bolts where they go through the prop hub. Wear on each side which indicates to me that the prop hub was rotating very slightly in relation to the drive hub. The bolts were all torqued correctly and the 1" aluminum shaft nut was torqued to 100 lb ft. This engine has no harmonic dampener or flywheel, which is a departure from most conversions. It could be that the 3 power pulses per revolution and the 3 times per revolution the prop has to drive the engine was just too much for this drive design. Some flex caused wear which caused more loosening and that cascaded until it was too loose.

As far as I know no other Corvair conversion has this much displacement with this type intake system with fuel injection and electronic ignition. In short other Corvairs won't make this much power. I don't know of anyone else working on this type either.

That's my take on it now and since we didn't find anything else I think it is pretty solid.