The Trailing Edge

April 2023

When Things Move That Shouldn't…

So, on a recent Saturday I'm doing the condition inspection[1] on my Bearhawk. Because the airplane has only been flying for 13 years, has only 818 hours on it, I'm the only one who flies it, and it spends most of its time happily sleeping in its private hangar, the inspection is usually mostly an exercise in looking at everything and seeing that it is still where it is supposed to be. I like that it is usually devoid of expensive surprises.

Inspecting the starter is usually a case of looking at the starter, seeing that it is still there, with all of the nuts still in place and the wires still attached. It has been working as expected for the last year, so why should anything be amiss? One part that does get a special inspection is the pinion gear that engages the ring gear—this is a location that is expected to wear, so I look for any signs of wear or damage.

Everything looked fine this year, until…

I was reaching for something else, and I happened to bump the back end of the starter. As it happens, I just happened to be looking at the mating surfaces between the front half and the rear half of the starter. When I bumped the rear half of the starter, the oil line on the mating surfaces CHANGED! The parts separated by maybe half a millimeter (known better to old mechanics as "a few thousandths"), but they're not supposed to move at all! This set off the usual litany of troubleshooting:

1. Denial. I did not see that thing move. It's not supposed to move. That is not what I saw.
2. Questioning. Did I really see that move? Try it again. That sure looked like it moved, but it's not supposed to. I must have done something wrong.
3. Confirmation. Try it again. Yep, I'm pretty sure that moved.

4-n. Reconfirmation. Repeat Step 3 over and over again, hoping that the result will change.

n+1. Spread the pain. Send e-mail to your other aircraft owner friends, bewailing your tale of woe.

n+1.1. (Optional) Take a video of what you are seeing/wish you weren't seeing and send it to your aircraft owner friends

n+2. Research. Search the web to see if anyone else has had this problem.

n+3. Hope. Hope that maybe someone has a solution.

n+4. Resignation. Impatiently wait until Monday morning and call Tech Support, steeling yourself for drama.

The common wisdom on the Interwebs is if something is supposed to move and doesn't, WD-40. If something moves and it's not supposed to, duct tape. Unfortunately, I didn't think duct tape was going to work in this instance.

Background

Back in 2004, I had purchased an engine for my Bearhawk project, but it came with no accessories. I was shopping for a starter, and my AirVenture travelling companion suggested I consult with Sky-Tec, a fairly new company that was making a name for itself by producing "light weight" starters. "Light weight" because they were about half the weight of the re-purposed automotive starters that had been in use for years. I liked the fact that the company was in Mineral Wells TX, as that was very close to where I had grown up, and at one time I had planned to be based at that airport.

I told the Sky-Tec booth rep that I needed a starter for a Lycoming O-540. Without a pause, he very excitedly told me that what I needed was their ***NEW*** "NL" (for "in-line") starter. Instead of having the motor next to the gearbox, the motor was behind the gear box (hence "in-line"). This fit on the engine better and was a better use of space. Because the starter has a gearbox, it is able to use a smaller motor that turns at a higher RPM. This is how

[1] This is what owners of certificated aircraft call an "Annual Inspection". However, an "Annual Inspection" is defined as an inspection that is required once a year to show that the aircraft is in compliance with its type certificate. Because Experimental Amateur Built aircraft have no type certificate, they can't be shown to be in compliance with said non-existent type certificate. However, a "condition inspection" is required each year to the same level as an "Annual Inspection". Even though the "condition inspection" is required once a year, it can't be called an "Annual Inspection" because that has a legal definition. Don't you just love lawyers?

they get their weight savings. Because it was larger overall than their other options, it would be under less stress turning over a big six cylinder engine.

Suitably impressed, I ordered up a Sky-Tec 122-NL starter for myself. (The "122" means it fits a ring gear with 122 teeth. The other option, the 144-NL, fits a ring gear with 144 teeth.) Soon I received a starter, serial number CN-270410, which I recently found out means that it was the tenth starter built in the 27th week of 2004, so this really was an early version.

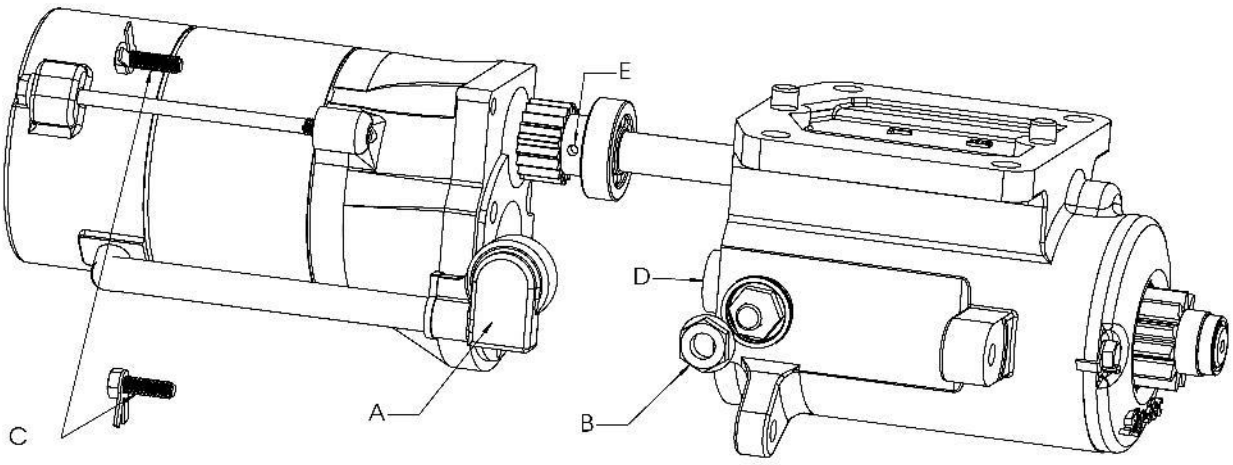
Apparently, I did make a good choice. Every other Lycoming (I)O-540 engine I have seen has the same type of starter.

Starter Getting Weak

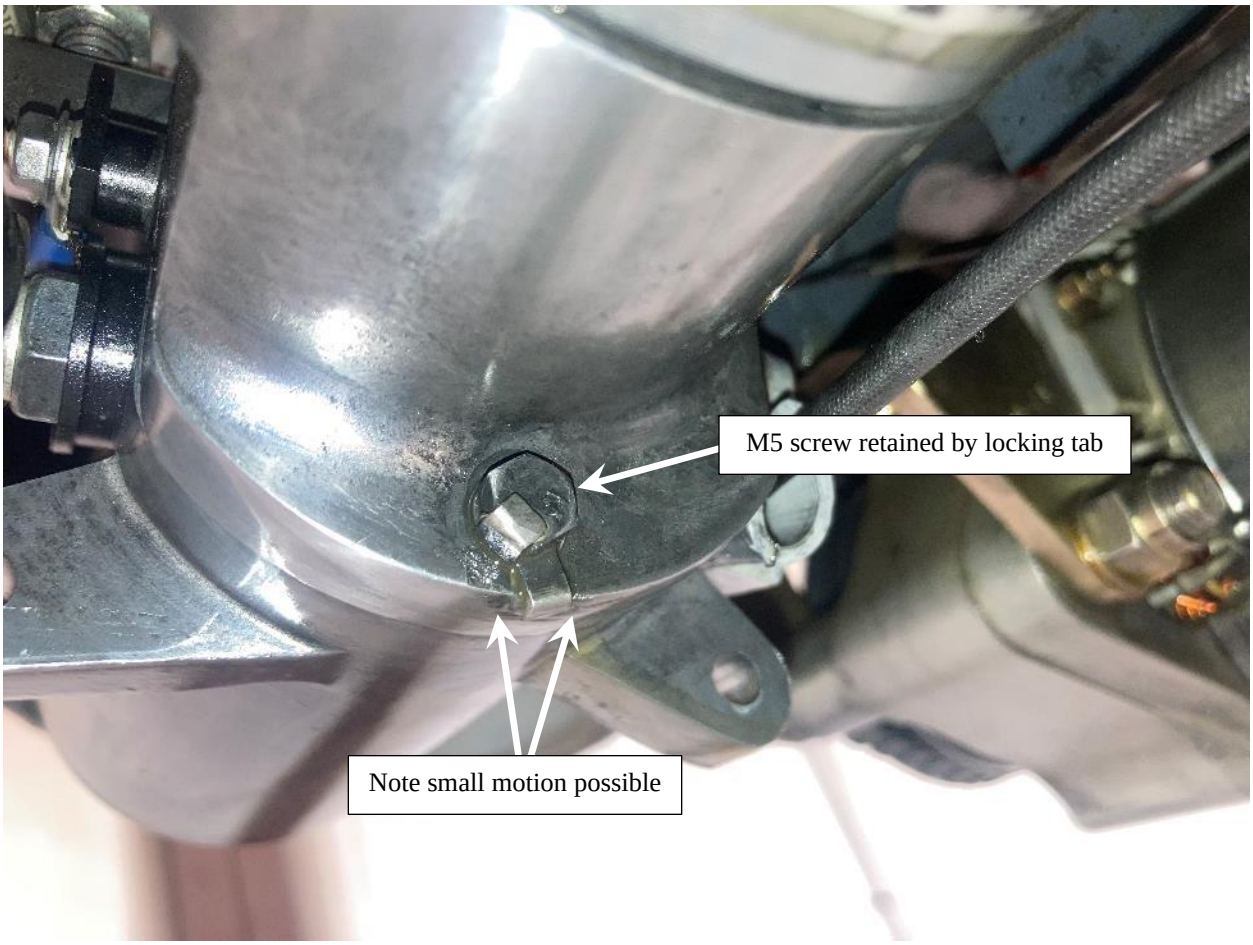
The starter was bought in 2004, but the airplane didn't fly until 2008, and then not regularly until 2009. Come 2014, the starter was starting to have problems turning over the engine. I had to move the propeller until I felt a compression stroke, then back it up to the previous compression stroke to give the starter a running start at getting past the first compression. At this point, the airplane had 357.9 hours on it, which is probably over 400 engine starts. Sky-Tec had me run several tests to make sure the starter was getting sufficient voltage, because "that is usually the problem". All of those tests were passed. They finally told me to pull the starter and send it to them. When they received it, they were surprised to find the internals were pretty messed up. I seem to remember the gear box had a lot of wear and tear. They offered to rebuild the starter to new specs. I have no records of having to pay anything other than the cost of shipping to get the starter to them. The starter was re-installed and worked very well up until this inspection in 2023. At this point, the airplane had 460.1 more hours on it since the starter was overhauled.

Time to Call in the Experts

So, Monday morning finally came, and I called the Sky-Tec Tech Support line. I was greeted by a very nice man who asked how he could help. I described my tale of woe, and his response was (not an exact quote, but essentially) "That's a known problem. We'll take care of that for you." He asked for the serial number, and told me that my starter was built in Mineral Wells in 2004 and was of the very early design. He went on to explain the history and the fix. Back in 2016, Hartzell Engine Technologies recognized a good thing and bought the Sky-Tec company, moving it to Montgomery AL. Somewhere around 2018 (I don't remember the exact date), they recognized that there was an engineering deficiency in the NL starter design.



In the drawing above, the two halves of the starter are shown separated. These two halves are held together by two (2), count them, two, M5x25mm hex screws (part "C" in the above figure). For those of you not hip to metric fasteners, that's roughly equivalent to an AN3 bolt (3/16 inch diameter) 1 inch long. Not very big. I assume there are some bosses where the two parts join to absorb the torque of the motor and the screws just hold the parts together. These hex head screws were torqued in place and retained by metal anti-rotation tabs. This system was actually the fix to the original design of Phillips head screws with lock washers.



I was told that the locking tabs on the screws were not strong enough to prevent the screws from loosening in the high vibration environment that the starter lived in. Time for some recreational maths. The thread pitch on an M5 screw is 0.8 millimeters. If we assumed that the screw backed out one-sixth of a turn (i.e. one flat), that would mean that the screw would move out 0.1333 millimeters, or 0.005 inches (i.e. "five thousandths"). That's about the same thickness as a "normal" 20-pound sheet of printer paper. Since the screws are only torqued to 50 in-lbs, it is not surprising that they would back out under that much vibration.

Looking at five thousandths on my calipers looked very similar to what I saw on the starter. When things are supposed to have zero clearance and they have five thousandths clearance, that's a problem. It is clear that the bent metal tabs will keep the screws from fully backing out, but they won't prevent all movement. It looks like they can allow for about a sixth of a turn while still looking like they haven't moved at all. An interface with a gasket might be able to absorb this change, but these are two machined surfaces intended to have zero clearance.

The latest redesign is to use thread locker (such as Loc-Tite) and lock washers. He said they haven't had any problems since doing that. He had me fill out a warranty claim form and sent me an RMA. Now I send in my starter (at my expense) and they will send me a "new" starter. I don't know if that will be a "new" starter or if they will rebuild this one. Yes, I could probably tighten the existing screws and add lock washers and Loc-Tite, but if I send it in I feel like someone will inspect the starter to see if there is any other damage I might not know about. Airplane down time is not an issue since I expect it will be down for the condition inspection longer than it will take to get a replacement starter back.

He did say that he gets calls from some people with the same problem saying that there is "grease" leaking out of the starter. It's not really grease, but engine oil escaping the engine and mixing with aluminum particles that are rubbed off as the two machined surfaces rub against each other and "fret". This makes the oil turn black and look like grease.

Working with Tech Support was very straight-forward and devoid of drama. So much so that I almost felt cheated because I expected drama. Being upset because you expected to have reason to be upset but you didn't have that reason and got exactly what you wanted is really messed up.

Starter Reinstallation

The starter was shipped back to Sky-Tec (at my expense). As they promised, Sky-Tec sent me a brand-new starter with a new serial number. This was a "warranty" repair and cost me no additional money. The new starter has the same screw with a lock washer under the head. I presume there is thread locker on the screw as I was told.

Takeaways for You

If you have a Sky-Tec NL starter, try pushing the rear end around and see if there is any movement at the joint in the middle. If the two halves of your starter are held together with hex screws with metal tabs bent around them, you will probably have this problem eventually. If you bought your starter before 2018 you will probably have this problem eventually. The good news is that if you contact Sky-Tec (a division Hartzel Engine Technologies) Tech Support, they will fix it as a warranty repair.

Recommendations

Would I still recommend to someone else to buy the Sky-Tec NL starter? Absolutely! Airplane parts are expected to require maintenance occasionally. I bought a very early example of a new product and it has mostly worked as expected. It is quite reasonable to have improvements to a product over the space of almost 20 years. It does the job very well. I also have a Plane Power alternator (also bought out by Hartzell Engine Technologies) I bought in 2009 that now has 772 hours on it, all trouble free.