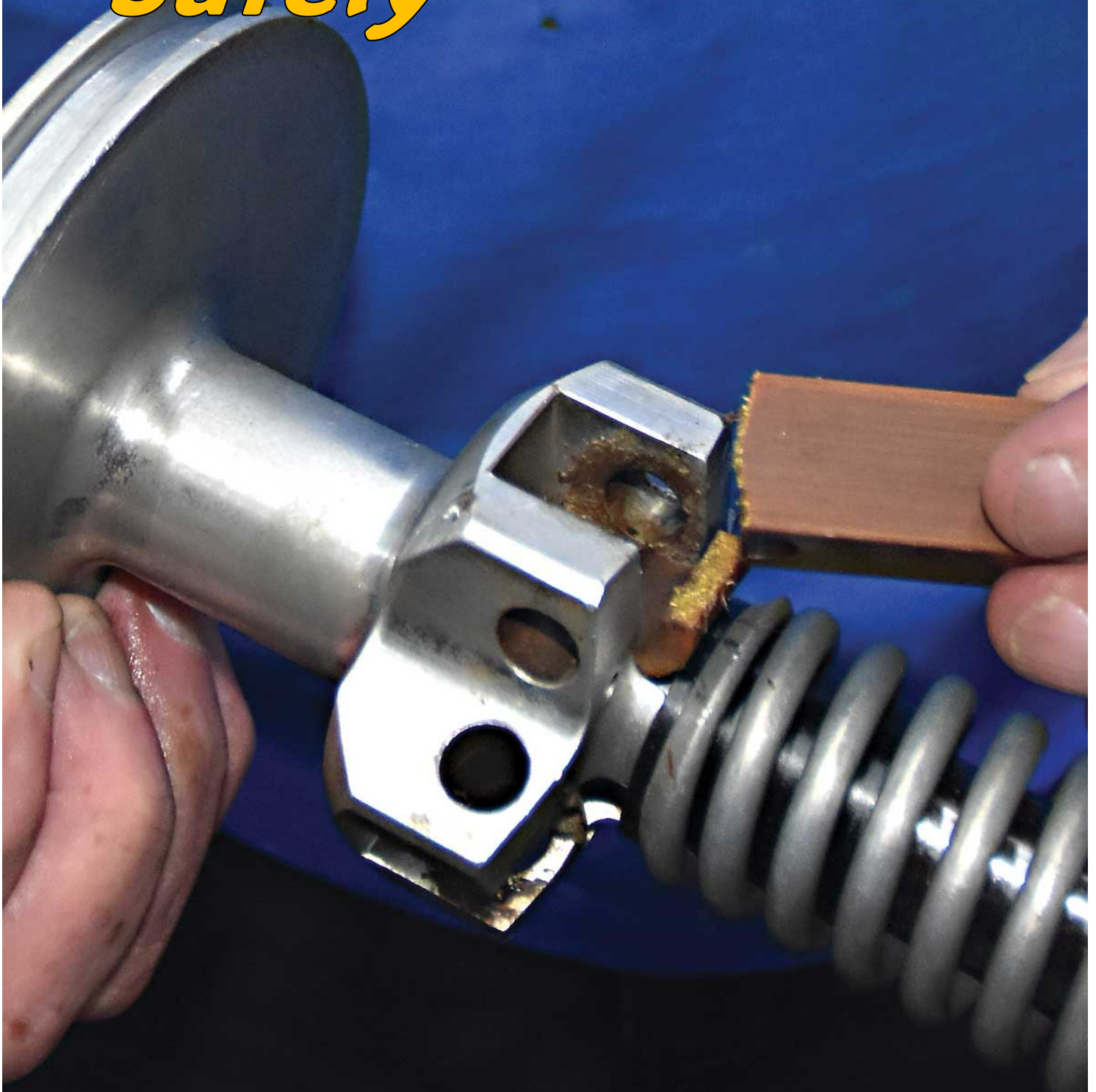


*Prop Detectives
Keep Us Flying
Safely*



Prop Detectives Keep Us Flying Safely

By Mike Jones

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Cessna Pilots Magazine, originally published: October 2023

The last few issues of this newspaper related the adventures Nick Phan and I enjoyed on our way to and from Oshkosh 2023. But the thread for today's missive, dear reader, is a big "gotcha" that nearly brought our happy trip to a catastrophic close. And I don't use the term "catastrophic" lightly.

Flecks on the Windscreen

You'll recall that Nick and I were flying in my 1979 Cessna T210. I've put well over 2,000 hours on the airframe, flown more than 100 AngelFlight missions, more than 800 Young Eagle rides, along with endless hours for business and pleasure. I assert without hesitation — and probably kickstarting a hailstorm of nastygrams from Skylane owners and Cardinal addicts — the Centurion is the world's most perfect plane. For me, at least.

By nature, I'm a frugal soul. I'll stint on meals and hotels, skip birthday presents, and "forget" anniversaries. But I never cut corners on airplane maintenance. If something ain't right, that plane doesn't fly. That's just me; your mileage may vary.

Just before Oshkosh, I noticed tiny flecks of oil on the windscreen. My amazing A&P quickly and correctly diagnosed it as a failing seal in the constant

speed prop. This was not an urgent condition but an early warning that the prop would need TLC in the near future. Since it was not an immediate safety-of-flight problem, the experts agreed, Nick and I could safely soar to AirVenture as planned. It was such a good plan, and it worked perfectly, as you have read.

The next morning after our return, I taxied old '91N to the maintenance hangar, tossed them the keys and went on my way. I was very surprised when they called me that same afternoon, to ask about the water in the prop hub.

Water? There's no water inside a prop hub. But they estimated a full two pints of water had spilled from that prop, as evidenced by the mess on the hangar floor. Scratching our collective heads, we agreed this minor issue instantly had graduated to a serious worry.

"Off with the prop," I bellowed like the Prince of Denmark, "and get thee to a prop shoppery!"



This is the H&H "waiting room" where props are stored prior to their inspection and repair. H&H has a good-sized facility but props chew up a lot of floorspace. There are sixteen prop assemblies in this photo and probably an equal number out of the photo, on the left. Notice the number of blades with bent tips, indicating the prevalence of prop strikes. In the back, the large three-bladed brown box houses a new prop just coming in from the factory.

Burlington Bustle

Kenny Martin is the shop supervisor at H&H Propeller Services, at the Burlington, NC airport. Martin is a big man, a gentle and loquacious soul, round of body and grey of hair. He joined H&H straight out of the Navy in 1983. Martin had strong mechanical skills so the Navy recommended him to H&H because they knew H&H had a strong on-the-job training program.

“The guys here back then, they said, ‘Ok we’ll give you a shot.’ I had some training, like I had worked on cars. So they hired me. Now, 40 years later, here we are, still doing the same thing.” Not quite: in fact, Martin now runs the show.

H&H is a mid-sized prop repair facility, serving customers inside a giant semi-circle running from Maryland out to Kentucky and down to Georgia. Since props travel by truck, the markets are roughly defined by the distance a pickup can travel in a day. H&H repairs Hartzell, McCauley, and Sensenich propellers for both piston and turboprop aircraft. They also repair the most popular prop governors and accumulators. “The closest competitor would be in Georgia,” Martin said, “and there’s another one in Pennsylvania.”

“I’m proud of our reputation,” Martin told me. “All our business comes from word-of-mouth. Our trucks run up and down the coast, picking up props.



Kenny Martin is a gentle and gregarious soul with more than 40 years of experience in repairing props of all sizes, shapes and conditions. It was Martin who broke the news to Mike Jones that the prop on his Cessna T210 was worn beyond saving; a \$20,000 bit of bad news. The template in Martin’s hands features the “station” markings that are the benchmarks used to determine if a blade is still airworthy or must be scrapped.

You won't ever see us advertise," he said, an admission which breaks the heart of many publishers.

I was surprised to learn Martin and his team are not certified A&Ps. They have totally different tickets called "prop and accessories repairman" certificates.

"I work on things A&Ps aren't allowed to touch. An A&P can dress the edge of a prop, for example, but isn't allowed inside a prop hub," Martin explained. "In the same way, a prop mechanic can't fix an engine."

"In my opinion, the prop governor is the hardest working piece of any aircraft!"

– Ken Martin, H&H Prop Services

Looking around their shop, dozens and dozens of prop assemblies were visible, from tiny props to huge four-bladed monsters. "We can work on any prop as long as it's from a fixed-wing aircraft. We do singles, twins, turboprops, warbirds and even the

Commemorative Air Force B-17 and P-51. We used to do military planes, C-130s from Seymour Johnson; we tore down a lot of C-130 props. They're just easier to ship in a tore-down condition, so we'd send all the parts out, and when they came back, we'd put them back together."

"The biggest prop I've ever worked on was a Corsair from World War II. That sucker is unbelievable, you just can't believe how big that prop is. It took up almost the whole shop."¹

¹ I did a little research on Martin's claim about the Corsair's prop. The F4U was the first American single-engine airplane to achieve 400 mph in level flight. The F4U used the largest engine available at the time, the 2,000 horsepower, 18-cylinder Pratt & Whitney R-2800 "Double Wasp" radial. The engine converted avgas to speed with a Hamilton Standard three-blade prop which was 13 feet in diameter. The prop was so large that the airframe didn't offer enough ground clearance. Convair's solution was the famous and iconic inverted gull wing, basically lowering the bottom of the airplane while keeping the prop high. 13 feet is big, but the Spruce Goose had 17-foot diameter props while my personal favorite airplane of all time, the B-36, had 19-foot monsters.

Forty years of tenure with one company is rare these days, and I asked Martin if the business had changed in his time. Surprisingly, he said the industry hasn't changed much but H&H has evolved substantially.

"When I first came here, everybody had to grind [the edges of props]. I spent seven and half months grinding, eight hours a day. There's an art to grinding, you know. You can scrap a \$7,000 blade in a heartbeat if you don't know what you're doing with a grinder. You only graduated out of the grinding room when somebody in the shop left, so you took their job and the company would hire a new grinder," he laughed. "But it's not like that anymore. We were losing 80% of the people we hired because they didn't want to spend their life grinding. So now we hire them and train them as mechanics; and then teach them to grind. Even today I still grind my own blades."

But there are limits. "We don't work on wooden props anymore, like when I first started," Martin recalled. "And I think it was '85 or '86 we also stopped working on steel props. That was a business liability thing, because of the way the FAA wrote the AD on steel blades."

The hardest part of the prop repair job is diagnosing intermittent failures. Martin introduced me to John "Raynor" Wiygul, one of the experts at H&H, who was working on the left prop from a popular light twin. The pilot had reported the prop "didn't feel right" and thought it might not be changing pitch in response to the prop control. Wiygul had attempted to replicate the problem on their test bed, but wasn't finding anything out of spec. When I arrived, he was deep into the manual for the prop, but Martin suggested more testing.

"A manual is just a dead cookbook. It's only going to tell you what happens when everything works perfect," Martin coached him. "If it's not perfect, that manual isn't going to tell you anything. It's great to learn the manual, but what's better is putting it up against what actually happens in the field."

He turned to me and continued. “It’s totally different, the real world, and that’s our challenge, to find out why. We’re kind of propellor detectives.”

Another worry is corrosion, especially on steel blades. Many steel blades were made by Hamilton Standard, and they haven’t made anything new since the 1960s. “Sometimes parts go out of stock. The Beech 18s, the warbirds from the ’40s and ’50s – I love working on them. But you can’t get new blades for them. If there’s corrosion and you can’t find new parts or cannibalize used ones, you’re just out of an airplane.”

I noticed many of the props in his shop sported the distinctive curved tips of a prop strike. Martin agreed, and commented that both retractable gear



Inside the prop hub on Jonesy’s Cessna T210, the prop control mechanism was heavily worn and rusted. One of the counterweights (rusty orange part) actually broke off in the mechanics’ hands, while others were so corroded the technicians had to break their retaining pins to remove them. The powerful spring puts pressure on the blades to return to the flattest pitch, which is the “default” position used for take-off. The oil pressure from the governor opposes the spring to allow pilots to adjust the pitch. Constant speed props usually have a six-year/2,400 hour life before refurbishment, and Jonesy’s prop had gone “a little” beyond that recommendation.

aircraft and taildraggers were good for business. He strolled through the workshop, pointing out the damage.

“This was a prop strike, caused by a gear-up landing on a [Cessna] 337 in West Virginia. Here’s one, here’s another, there’s another over there. We get so many coming into the shop. Gear up is good for McCauley and Hartzell, but we actually make more money overhauling props than we do selling somebody a brand new one.”

Surprisingly, a bent prop is not always scrapped. “If it’s not too bent, if you just kiss the runway, we can straighten it right out,” Martin said. “We’ve got a 40-ton press, we’ll put the angles back in it. We also convert ‘climb’ props to ‘cruise’ props.”

One of the biggest changes at H&H was when composite blades were introduced. Composite blades are made from fiber glass and a material similar to Kevlar. They weigh less and come in sexy shapes, so I asked Martin if composites would be good on my Cessna. He scoffed at the suggestion.

“When you see the pylon racing guys, everybody has composite props. They want the littlest amount of weight on the prop as possible, so it’s worth it,” he said. But performance is expensive. Martin estimated a standard aluminum unit for a Cessna 172 might be \$7,000 and weigh 25 pounds, but the carbon fiber version would be \$15,000 and only weigh 12 pounds. \$500 per pound of useful load? I didn’t think I could sell that to my almost-sainted wife. Lacking a Red Bull budget, I regretfully agreed.

Bad News for Old 7591N

We moved over to examine my prop. “It’s just beyond saving,” he said, almost sadly. To my untutored eyes I couldn’t see any damage, so I pursued the issue.

“It was the blades. They wasn’t enough material left on your blades,” Martin explained. “We have this template [for each make and model of a prop], and the template is marked with the required dimensions at key positions on the blade, called ‘stations.’ Each station has a minimum width and a minimum thickness for the blade. When any station gets below the minimum size, you red-tag it. That’s the end.”

I asked how this extreme erosion could occur. He explained that part of it is just normal wear-and-tear, caused by a fast-moving prop flying through dust, rain, or even ice. But most of the loss is from A&P mechanics.

“Your A&P might do a light dressing on the blade, a ‘light profile’ as they call it, to remove some nicks. When we overhaul the blade, we’re gonna take even more material off of it. You’re always taking material off and can’t put it back on.”



Prop balancing isn't a "nice to have" feature, it's absolutely essential to both safe flight and to the longevity of the prop, the engine, and the airframe itself. A prop that is out-of-balance and spinning at 2,700 RPM can literally shake an airplane apart. Here, Martin demonstrated the process for "static balancing" this two-bladed prop.

How bad was it? “On your blades, you were missing half an inch of the width of your blades. Your prop was 40 years old. It’s been profiled dozens of times, and eventually it just adds up. On scimitar blades, if you lose even a quarter of an inch of the blade, you’re done.”

But the blades weren’t the big issue on my Cessna, according to Wiygul, who had worked on the hub assembly.

“Well, I tore it down. I took the cylinder off and the water came out. It was pouring out of it,” Wiygul told me. “I looked at the grease and the bearings and the actuator. It was rusted, pretty bad.” Wiygul later told me that the retaining pins were so rusted they actually had to break them to remove them. “How all that water got in your prop I have no idea, but it was a mess.”

Martin confirmed, holding the pieces in his hands.



The H&H lab is able to put prop systems through all of the required tests before being returned to the field. In this case, Martin is boosting the oil pressure inside the hub of this constant speed prop to see if the blades change pitch as they should. Notice his right hand is below the workbench, turning the valve that controls the flow of oil. This is the same function the prop governor performs on the plane in flight. John “Raynor” Wiygul and Jonesy watch as Martin moves the blades slowly and silently, almost magically, back and forth.

“I can’t say for sure, Mike,” he said, “but I’d guess your prop was just a few hours, maybe 20-30, maybe less, from a catastrophic failure.” It is sobering when a forty-year expert calmly describes a bullet you just dodged that you never saw coming. Nick and I had flown across Lake Michigan and the mountains of West Virginia, hanging from a prop that was “hours from failure”?

By the time you read these words my old prop will have been smelted into new Toyotas or soda cans. After some discussion, we settled on a new Hartzell scimitar system as the replacement.

“Your new blades are going to look different. They’ll be fatter, much fatter,” Martin explained. “The prop will take a bigger bite of the air, you will

get more pull. You'll have a lot more blade grabbing air than you've had. It will be quieter, and she'll fly like a new airplane."

Sign me up, Coach!

Around the Shop

I watched Ryan Colberson paint a set of parts while refurbishing a prop assembly. He had just ground the blades down to re-surface them, and was just a few hours from putting it all back together.

"I've only been here three months, learning the ropes, and Kenny's been teaching me," Colberson said. "After an overhaul, if it's well cared-for and in a hangar, a refurbished prop will last six, seven years. But never go more than ten years; that's the shelf life of the O-rings."

About fifteen people work at H&H, and even more work at the engine overhaul shop which is its sister company in the same building. Here Ryan Colberson, a new employee with just three months on the job, is cleaning and painting hub components as he refurbishes a prop assembly. He had just finished grinding the blades and was only a few hours from putting it all back together. Jonesy was impressed by the tidiness and organization of the parts on the workbench, indicative of strong organizational protocols.



Martin agreed, but said some folks push the limits. "The factory recommendation is every six years or 2,400 hours. I've had people go longer than ten years. They figure if it's working don't mess with it." Quickly recognizing myself in his words, I changed the subject and asked him how he kept the shop so organized, with so many different props from different planes.

The key, he told me, are called “travellers.” When a prop arrives, H&H researches the official parts list, the serial numbers, model numbers, and work order numbers. After the prop is disassembled the parts are placed into pans, and those pans and paperwork together are called “travellers.”

When the prop moves from one place in the shop to another, the traveller goes with it, hence the name. If the blades leave the shop — for example, to be anodized — the traveller takes a time-out on a special shelf. When the prop comes back to H&H, they match it with the traveller and together the parts and paperwork finish their journey. It’s a simple discipline but highly effective.

Martin was eager to discuss prop balancing. At H&H, they do two types of balancing. First there is a “single blade” balance which matches the weights of all the blades in an assembly.

“First you find the heaviest blade, and you add lead to the other [lighter] blades until they all weigh the same,” Martin explained patiently. Then the entire assembly goes to a balance post and the whole mechanism is re-balanced as a finished assembly.” That second process is called static balancing.

Dynamic balancing is a third process, but it requires the prop to be mounted back on the aircraft. “Dynamic balancing cuts down on vibration, minimizes engine wear, avoids damage to avionics, and curtails airframe cracking. “It is excellent. I highly recommend it,” Martin said with emphasis. “Long-term, that little extra vibration you’re removing from that engine is huge.”

The last part of the H&H tour was to the governor shop. On a constant speed prop, a tiny device called a governor controls the RPMs by constantly changing the pitch of the prop. A governor is an ignominious little widget, easy to overlook — just about the size of a six-ounce soda can. But they’re near-and-dear to Martin. “In my opinion, the governor is the hardest working piece of any aircraft!” he exclaimed.

“You gotta remember, after take-off you set your RPM with the governor and basically never touch it again,” he said fondly. “You climb, descend, bank left and right, fly through turbulence, all sorts of things. All that time, the governor is changing the blade angle automatically, for hours and hours. It’s adding oil pressure and taking it away using tiny little fly-weights. The engine is working hard, too, but this little guy is constantly in motion, constantly adjusting. It’s just an amazing invention.”

H&H is proud of their governor test rig, which is a large, black antique that looks like a prop from an old “Doctor Who” episode.



This large system is a simulator to test the performance and the precision of prop governors. Martin asserts the constant-speed prop governor is the “hardest working part on an airplane.” This simulator, despite its obvious age, can put a governor through more stress than it would ever see in flight, so H&H can be comfortable the machinery will work as advertised.

“All this machinery is just to calibrate and test this little governor,” Martin said. “Anything an airplane can do, I can duplicate with our test rig. Airspeed, RPM, climbs, dives, oil pressure, I can simulate anything and everything. If it survives on this bench, it will out-last anything your airplane could put it through.”

A Great Career

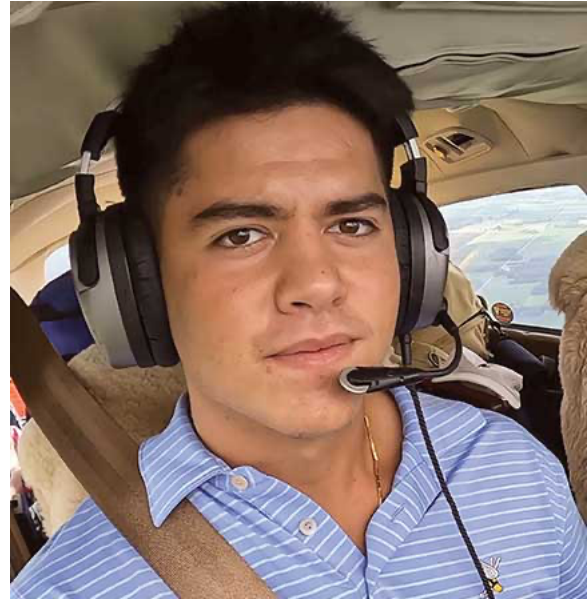
As we were finishing, Martin grew philosophical. Like most jobs, prop work can have its frustrating days and have some interesting days. After 40 years, he particularly enjoys it when they solve problems somebody else couldn't figure out. "It's like a puzzle. I learn new things just about every day, and I've been doing this a long time."



Out with the old, in with the new. Here Brandon Smith (left) and Steve Brown from Pinehurst Aviation Services finish installing the new Hartzell scimitar prop on to the nose of 7591N. It does look sexy... Jonesy can't wait to see how it flies.

News Flash

The readers of this magazine will be pleased to learn that Nick Phan, whose adventures at Oshkosh 2023 were featured in several of these most recent issues, successfully earned his private ticket on November 7, 2023. He also scored a sprightly 93 on the written exam, which is simply ostentatious overkill. His next stop: a float-plane rating, and then off to bush flying in Alaska. Congratulations, Nick!



About the Author

Mike Jones is a 4,000 hour commercial-rated pilot who enjoys camping at airshows and sleeping under the wings of his 1979 Cessna Centurion. He just earned his doctorate from the University of Florida, and his dissertation dealt with the management issues found at small airports. Look for Jonesy at airshows and fly-ins across the country in 2024. He's always accessible at PilotMike2012@gmail.com.

