



Precision powerplant

Ultimate Engines works its magic on a tired O-540

BY THOMAS A. HORNE

Renewing and upgrading the engine and propeller are standard procedure with every AOPA sweepstakes project airplane, and so it is with AOPA's Win A Six in '06 Sweepstakes airplane. But this year there's a twist on this massive work package. This year, we're overhauling the engine and propeller that came with the airplane, a 1967 Piper Cherokee Six.

In previous years, we'd simply swap out the old engine and propeller, trading them for factory-fresh engines and props. That, of course, is the fastest way to owning a like-new engine and prop. Overhauling can take longer, because components must be shipped out to vendors for inspection, rejection (if the parts are worn beyond tolerances or flunk operational tests), and rebuilding—if necessary. In the process, there's a great opportunity to learn about engine basics, and the ins and outs of the overhaul process.

When Ultimate Engines—our overhaul shop, based at Mena Intermountain Municipal Airport in Arkansas—received the Win A Six, its 260-horsepower Lycoming O-540 engine was nearing its recommended time between overhauls (TBO) of 2,000 hours. A brief first external look at the engine (viewable on a video on the sweepstakes Web site—



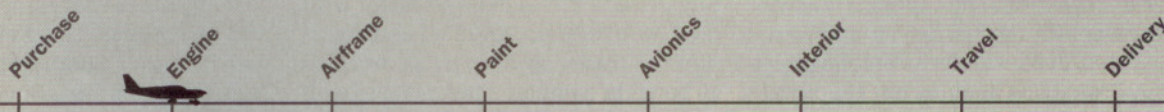
Ultimate Engines' Mike Wagner fits the newly balanced connecting rods to the crankshaft.

www.aopa.org/sweeps) quickly proved that the Lycoming was showing every bit of its 1,900 hours in service. Signs of wear, oil leakage, and repairs were everywhere. Everyone wondered what an internal inspection would reveal. Would the engine be a basket case and need

everything replaced? Or would most of the components meet specifications in spite of their advanced times in service?

To find out, Ultimate de-mated the engine and prop from the firewall, then disassembled them, and shipped out the components to other shops partici-

Project Timeline

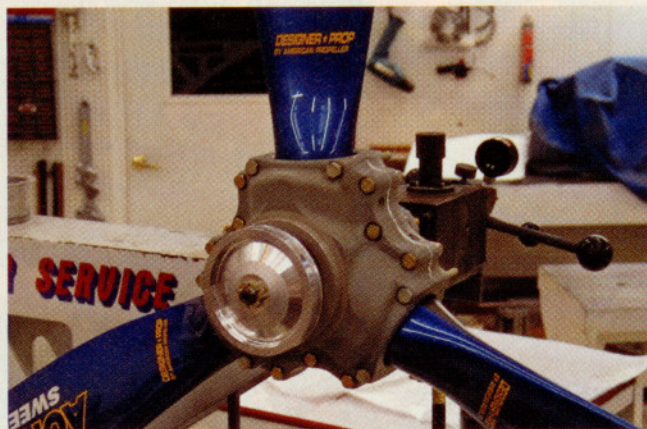


pating in the sweepstakes effort. Here's a quick rundown of their fates:

Crankshaft. This heavy-duty component is the heart of the engine. The connecting rods and pistons are attached to it, and as the pistons rise and fall in their cylinders, so the crankshaft ("crank," for short) rotates, sending power to the propeller. Our crank went to Aircraft Specialties Services Inc., of Tulsa, a well-known component repair shop. A detailed inspection revealed that—*ta da!*—the crank was in pretty good shape, in spite of its age. There were no cracks, but there was enough wear to warrant grinding it down so that all journal surfaces were uniform. To make up for the material lost in the grinding, oversize connecting-rod bearings were installed. Along with the rest of the crank, the flange—which is at the front of the engine—was turned on a lathe and polished. Then the flange was given a cadmium baking treatment to protect it from corrosion.

Camshaft. As the camshaft ("cam," for short) rotates, its lobes open and close the intake and exhaust valves. It does this via cam followers that ride on the lobes, and push on the pushrods. Our cam, also inspected by Aircraft Specialties, flunked its inspection. Its lobes were pitted and worn past limits, so Aircraft Specialties tossed it out and swapped it with a like-new replacement cam it had in stock.

Cylinders. Never once did we think of reusing the old cylinder assemblies. These are very high-wear items, so Engine Components Inc. (ECi) stepped forward with a set of its Titan cylinders. The Titans included not just the cylinders, but the pistons, valve assemblies, and cylinder heads as well. These cylinders' Nickel+Carbide barrel coatings promise less wear and long life, thanks—among other features—to what the company says is its superior ability to spread oil throughout their barrels. More reliable piston-ring break-ins and excellent corrosion protection are other features of the ECi cylinders. The Titans carry a two-year warranty against defects and workmanship. ECi's cylinder assemblies meet FAA-PMA (parts manufacturer approval)



quality standards. This means that the FAA has determined that ECi can build its components to original-equipment-manufacturer (OEM; in this case, Lycoming) production-quality standards, using approved production methods and skills. In other words, build to good-as-original measures.

Connecting rods. These passed inspection. The connecting rods' bolts and nuts were replaced as a routine procedure.

Magnetos. We decided to do away with the engine's stock Bendix magnetos. Unison Industries' LASAR ignition system will be installed in its place. The LASAR uses a microprocessor-based electronic engine control system to optimize spark timing for a wide range of ambient conditions and power settings. Starts are easier and faster with the LASAR system, and fuel consumption in cruise can drop by as much as 10 percent, compared to fuel flows with



After American Propeller paints the prop, it's wet-sanded with fine-grit sandpaper (top left). Buffing (top right) brings the paint to a high luster. The back of the prop is painted, and the bearings are packed (above, left and right). Finally, blades are installed in the hub (left).

conventional magnetos. The LASAR system comes with a new wiring harness and a set of its new Autolite XL fine-wire spark plugs.

Crankcase. Divco Inc., a crankcase repair shop in Tulsa, checked the case for cracks (there were none), machined the mating portions of the case halves for a good seal, then bolted the case halves together to make sure the bores for the crank and cam were perfectly aligned. Everything checked out, so the case halves were returned to service and sent back to Ultimate.

Engine mounts. These were cleaned, inspected, repaired, and returned to service by Kosola and Associates, of Albany, Georgia.

Exhaust system. Dawley Aviation Inc., of Burlington, Wisconsin, cleaned and welded the exhaust stacks, and also checked and cleaned the muffler and cabin- and carburetor-heat shroud assemblies. To look at the repair work, you would never believe how crummy the original components looked. Take my word for it.

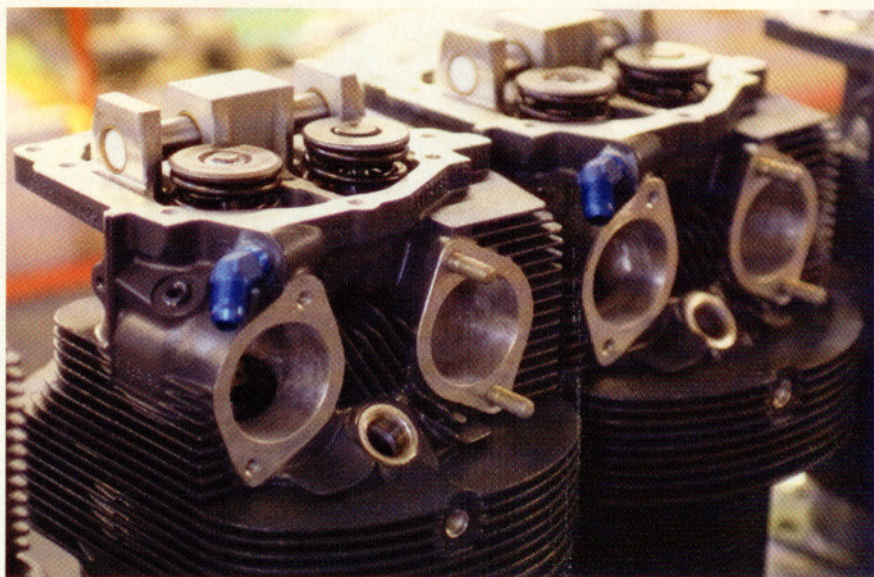
Accessories. Many thanks to so many other contributors that pitched in with so many other vital components, parts, and assemblies. Like Kelly Aerospace, with its starter, alternator, and carburetor overhauls. B&C Specialties came

through with a standby alternator—which we'll discuss at more length in subsequent updates. Precision Hose Technology added a new set of hoses, Rapco gave us its new wear-indicating vacuum pump, Western Skyways offered crankshaft and alternator gears and other parts, Quality Aircraft Accessories overhauled the engine-driven fuel pump, and Aerospace Products International kicked in with a crankshaft idler gear and other small—but essential—crankshaft parts. Last, but certainly not least, The New Piper Aircraft Inc. pitched in with engine baffling. The original baffling was a sight to see—cracked, welded, bent—and the factory-new baffling will look great when the airplane goes on display. It's nice to know that New Piper still stocks parts for its older, out-of-production airplanes, and that if parts aren't in stock it can many times fabricate new ones.

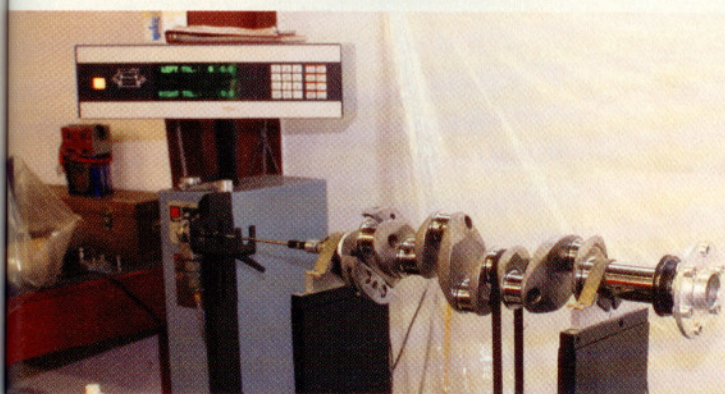
Propeller. American Propeller Service took a good look at our original two-blade propeller and didn't like what it saw. The blades had been overhauled in the past, and had been filed and ground to minimum specifications. On top of that, the blade shanks were worn past limits, and showed signs of corrosion. There was only one course of action: Toss the old prop in the garbage can and buy a new one. In a way, this worked to the airplane's benefit. Now we have a brand-new, three-blade Hartzell propeller. It should make the airplane run quieter and give the airplane more ramp appeal than the old two-blader, especially when you factor in American Propeller's Designer Prop paint treatment. This will feature color stripes matching the airplane's paint scheme, and the words "AOPA Sweepstakes" on the blade faces.

Once the engine's parts were reunited at Ultimate Engines, reassembly finally began. For Ultimate, this meant going far beyond simply slapping the engine together and firing it up. Ultimate's technicians measure all the engine components to make sure they meet the manufacturer's tolerances for a brand-new engine—a process called "blueprinting." And although the crankshaft was measured at Aircraft Specialties, Ultimate measures it again, just to double-check.

Then the crankshaft and connecting rods are balanced. Ultimate Engines' Chief Executive Officer Mike Wagner likens crankshaft balancing to balancing a car tire. If the crank isn't properly bal-



Brand-new ECi Titan cylinders (above) come with valve assemblies and matched pistons, but Ultimate polished the intake and exhaust ports for better airflow and more power. Crankshaft balancing (left) results in smoother operation, less wear.



anced and centered in the crankcase, its journals will not run true in their bores. "I'd say 90 percent of our cranks are balanced under one-half gram of weight," Wagner said. "This means that, if you were to look at it head-on, the crank journals run perfectly circular and in perfect balance in their bores. This means a smoother-running engine that lasts longer."

Connecting-rod balancing is another detail item. Wagner said that each rod is balanced to weigh the same; then each pair of opposing connecting rods is balanced once again. This means equal weights acting on the crankshaft as it rotates—another way Ultimate obtains smooth-running overhauls. The crankcase is deburred inside and out, and all camshaft lobes are ground to the same tolerances.

Wagner also adjusts the valves' hydraulic lifters so that valve lashes (the gap between the lifter and the valve head) are within very tight tolerances. "The factory gives you a range of gaps you have to meet, but we try to get the valve lash as consistent from cylinder to cylinder as we can," he said. With the

crank centered and balanced, the cam lobes matched, and the valve lashes the same, the engine is set up to run the smoothest it can.

When the overhaul is completed, Wagner will make an entry in the engine logbook: 0 since major overhaul, or "0SMOH" in maintenance slang. It's not a new engine, or a "zero time" engine (only an engine manufacturer can zero-time an engine), but it meets or exceeds the precision dictated by manufacturer specifications and tolerances.

As the engine and propeller upgrade draws to a close, I can't help but look forward to flying a rejuvenated Win A Six. It should run like a train on its way to the next stop in its transformation—to LoPresti Speed Merchants in Vero

Beach, Florida. Check back next month when I report on this next phase in this exciting project. **AOPA**

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i Links to additional information about the Win A Six in '06 sweepstakes may be found on AOPA Online (www.aopa.org/pilot/links.shtml).