The right choice can make a big dollar difference

Overhaul Or Factory Rebuilt?

By Ken Rose

Airplane maintenance is hideously expensive — and getting worse. Even the simplest airplanes have a talent for devouring owners' dollars. But maintenance cannot be avoided; every airplane needs an annual. Commercially flown airplanes require 100-hour inspections. One of the few choices available to you as an owner comes at engine run-out. Based on a guess about the condition of your airplane's engine, you can choose between having it overhauled and buying a new or factory remanufactured engine. The choice can make a difference of several thousand dollars for a single, twice as much for a twin.

Remanufactured engines deserve consideration. They can minimize downtime, and for owners of working airplanes this is a major consideration.

Paying a month's installment on the purchase price plus an insurance premium while losing a month's revenue during the time needed for an engine overhaul can make the price of a remanufactured engine much more attractive. Remans come out of their boxes ready to mount and fly; they offer very quick turn-arounds.

Remans are gambles, however. The credit you receive for the core (the old engine) may be cut drastically if the engine has unusable major parts upon factory inspection. Of course, some remanufacturers offer warranties which are more attractive then the factory warranties on brand-new engines, and this could be an economic plus for owners. Sometimes, though, the value of warranties is illusory. If an engine breaks, weeks or even months may be lost while it is shipped back and forth to and from the manufacturer's factory.

An overhauled engine can be cheaper than — and every bit as good as — anything an assembly line can produce. This is particularly true for airplanes that are flown primarily for pleasure or as family runabouts, where time pressures are minimal. The biggest variable in overhauls done by airplane and powerplant mechanics (A&Ps) in the field is cost. A mechanic can't know what he must do until he disassembles and inspects an engine. Indeed, the disassembly and inspection of components takes a significant portion of the total time — and therefore cost — of an overhaul. An honest mechanic can't make promises about price until he knows what an engine needs for renewal.

If you face an overhaul, there is a key to getting a good one. Pick the best and most type-experienced A&P you can find. They are no more alike than members of the other healing professions: doctors, dentists, nurses, therapists and veterianrians. In common, A&P mechanics heal airplanes and engines. Individually, they do it more or less well, with differing care and competence.

I have seen pilots select engine overhaulers solely on the basis of shop labor rates and blue-sky estimates. I am certain that none of these pilots has his major medical care performed by the low bidder. Perhaps they lack the imagination to understand that a poor choice of mechanics could put them into just as much danger as a mistaken selection of surgeons.

The most experienced and knowledgeable A&P is nonetheless an experimenter when he confronts a new engine type for the first time. He needs to go slowly and consult the engine manual frequently until he learns that model. A talented mechanic can produce as good an overhaul on an engine his first time as he can his 50th. Time is the problem; it will take him much longer the first time. If the mechanic of your choice doesn't know your engine model, you have to decide if you can afford to subsidize that phase of his education.

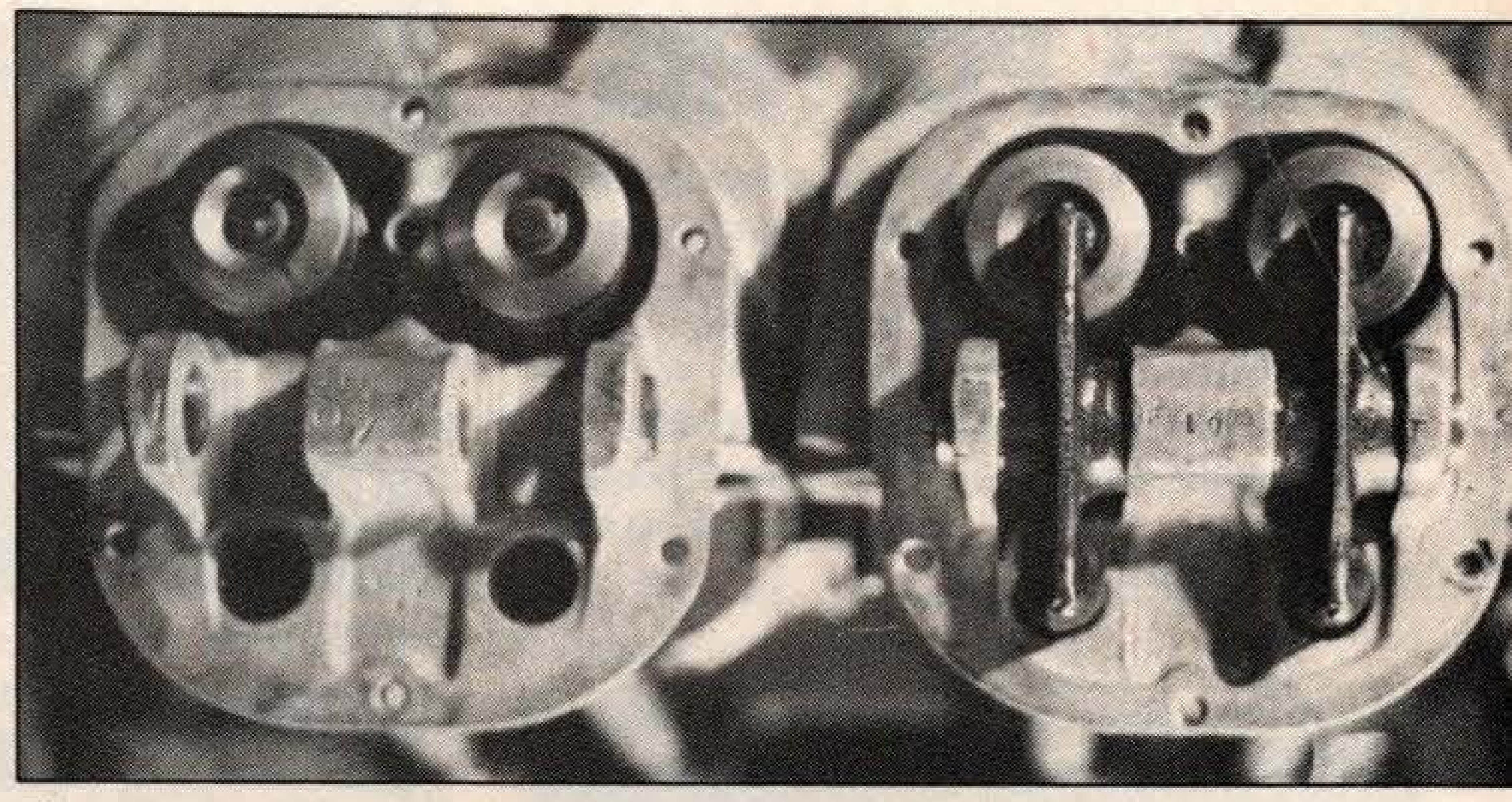
To illustrate what a powerplant overhaul requires, Bob Miles of Aviation Services at the Hayward, California, airport allowed us to follow an engine through his shop during its major overhaul. The engine was a Continental O200A, an engine widely used by homebuilders and the factory's choice to power Cessna's ubiquitous 150. A simple, direct-drive, normally aspirated (that is, unturbocharged), carbureted powerplant, without governor or propeller gearing, the O200A is a good choice to illustrate the basic steps and decisions an overhaul demands.

The particular O200A Bob had to overhaul was an experienced engine. Implanted by Cessna in a 1959 C-150, it had accumulated 2400 hours and logged two previous major overhauls, once at 754 hours, the second 601 hours later. The first two short-life overhauls reflected its use as a school airplane, facing the constant cycle of thermal shocks and engine overspeeds imposed by flight training. The current overhaul reflected a conversion to private pleasure use.

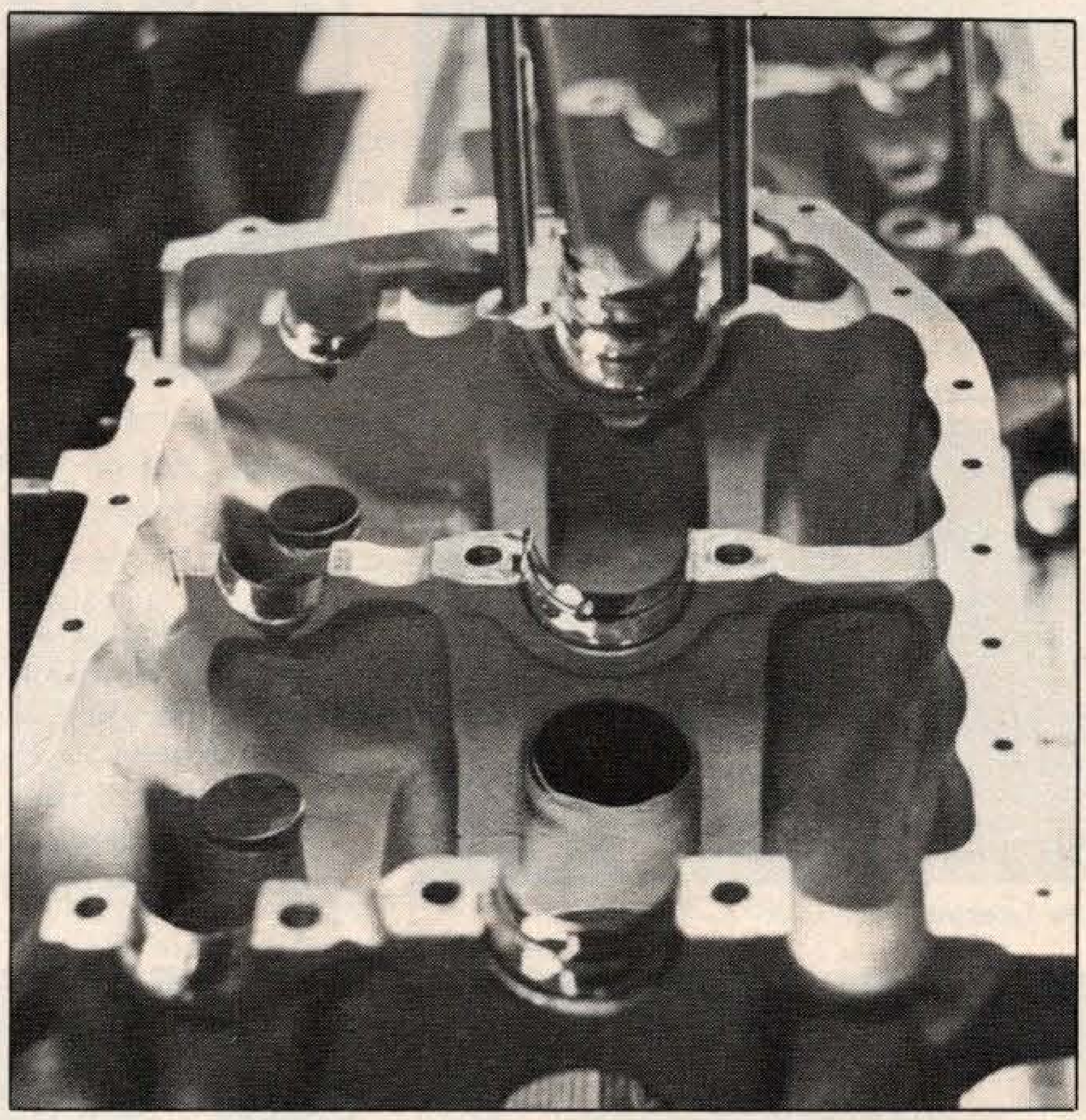
After removing the engine from the Cessna, Bob began the teardown and the accounting. As each accessory — magnetos, ignition harness, starter, generator, vacuum pump, carburetor — came off the engine he scrutinized it carefully, separating the items that needed repair and replacement from those that did not. Then the intercylinder baffles and the lower baffle were removed. Half of the lower baffle (it forces airflow under the engine to cool the oil supply) was broken beyond repair. It was listed for replacement.

With the accessories and baffling removed, Bob started on the engine. In less than an hour he converted a complete aircraft powerplant into a collection of separate parts on his workbench. He then cleaned all the parts before starting detailed inspection.

The *Overhaul Manual* for the O200A contains a Table of Limits which specifies exact dimensions for all critical engine parts. The table specifies both the limits for new parts and service limits. Parts that do not meet service limits must be repaired (when allowable) or replaced. The detailed inspection, then, determines the greatest part of the cost of a major overhaul — what needs to be purchased or reworked.



The valve springs required testing for tension and compression.



The case halves were sprayed with a dye penetrant to seek cracks.

Bob checked the dimensions of connecting rods, cylinders, pistons, crankshaft and camshaft. Additionally, he checked the crankshaft for run-out and its journals and crankpins for roundness. Springs required testing for tension and compression. Valves and guides needed measurement. Valves required visual inspection for necking.

At the end of visual and caliper, dial and micrometer checks, Bob found that three cylinders needed grinding to .015 inches oversize and that a fourth, badly scored in its wall by a broken piston ring, would require replacement. He had an oversized cylinder in stock to replace the damaged one. Since oversized cylinders require oversized pistons, four pistons and sets of piston rings joined the parts list. This first inspection stage revealed the need for $528 worth of new parts. On this overhaul the owner saved the cost of purchasing all new or replated cylinders, but, since oversized cylinders were used, the cost of the next overhaul was raised because normal wear will take the oversized cylinders beyond service limits.

The next inspection stage tested the integrity of the engine parts. The case halves were sprayed with a dye penetrant and sprayed again with a developer to seek cracks. All the ferrous engine parts except the hydraulic lifters were magnetized, subjected to a bath of magnetic particles, inspected under ultraviolet

Overhaul?

With proper run-in and careful use, an overhauled engine is capable of reaching factory 1800-hour TBO.

light and demagnetized. No cracks appeared, so the owner avoided additional parts costs. Engines can cost several times their new delivered prices when the parts are purchased one at a time.

When he had finished all inspections, Bob began the routines of preparations for assembly. He overhauled the Bendix magnetos, the starter and the generator. He discarded the wiring harness and ordered a Slick harness that he considers the best available. He replaced the intake valve seats in all of the cylinders. (This shows some of the created difficulties pilots and owners face. Because valve seats cut at a 45-degree angle to match the original valve face are no longer manufactured, Bob was forced to change all the intake valves to match the new 30-degree angle seats. A manufacturer's decision to drop the production of a part added more than $100 to the cost of this overhaul.)

Some steps in the overhaul are cosmetic. Mechanics routinely paint cases gray and cylinders Continental gold. Bob, in the interest of appearances and without charge to his customers, coats visible nuts, bolts, screws and studs with cadmium plating. He is a proud mechanic who wants his rejuvenated engines to look their suddenly reduced ages.

When all the accessories had been repaired and the ordered parts had arrived, Bob began engine assembly. (This waiting for parts often is frustrating to an owner because dealer and wholesaler parts inventories tend to be small; waits sometimes last several weeks.) Bob laid the left half of the crankcase in a special wooden cradle. Into it he placed the cam followers and half the main bearings. Atop the bearing he placed the crankshaft, already preassembled with the connecting rods and end gears. Beside the crankshaft went the camshaft, its end gear joining the crankshaft end gear at the tooth Bob had marked upon removal. The starter pinion pivot joined the back of the case half. Bob placed the front seal. Then he lowered the right case half, its bearings and cam followers in place, onto the half in the cradle. The core of the engine was together.

Next Bob tightened the case bolts hand-tight to hold the assemblage together. Final tightening had to await installation of the cylinders when precise torque values would be applied in a prescribed sequence, according to the engine manual. Bob turned the engine on its nose once he had sufficient bolts in the case to hold it together. He bolted the crankshaft flange to his engine assembly stand. He needed the engine vertical — and free to turn about its crankshaft — for final assembly.

Next he put rings on the new pistons and bathed them in oil — as he had oiled all the parts before assembly. Then, one cylinder at a time, the rings were compressed and the pistons were inserted into the cylinders. Individual lifters were placed inside the cam followers. Then the cylinders were held in place as Bob fitted pins to connecting rods, compressed the bottom rings and slid the cylinders down on the crankcase. All four cylinders rested on the case finger-tight.

With the cylinders in place, Bob applied the torque loads set by the manual to the through bolts, cylinder studs and case bolts. Everything had been left loose before to allow the case to move and align itself tightly as the torque loads were applied. Torquing determines the strength and seal of an assembled engine case. As further insurance, following a custom of experienced mechanics, Bob had run a single piece of sewing thread along the crankcase parting surfaces before joining surfaces together. The thread helped provide oil-tightness.

Bob now shifted attention to the rear of the engine, assembling the accessory drive, then putting on the crankcase cover. He mounted the starter and generator. Next he mounted the magnetos and timed them to the engine. Then he put spark plugs in the cylinders and installed the ignition harness. Following that, he turned to the cylinders to install the push rods. Finally, he installed the rocker box covers.

Bob placed the baffling back on the engine. Once the lower baffles were in place he replaced the oil reservoir and mounted the carburetor. The overhaul was completed. The engine was ready for return to the airplane. Before flight a test run would be required, in accordance with a table in the *Overhaul Manual.* Then the life of the engine passed from the hands of the mechanic to the pilots who would fly it during early run-in.

When Bob Miles finished the engine, he turned to the other part of a mechanic's trade: paperwork. First he did the FAA required writing. He listed the overhaul, parts used, and methods of work in the engine logbook. He added his stamp and signed his mechanic's license number along with the initials IA, to indicate his inspection authorization and his approval of the engine for return to service. The engine was now legal.

Then came the paperwork of interest to pilots and owners who pay the bills. More than a week of man-hours went into the little O200A. Even the simplest of engines is quite complex. Parts required were relatively few, but together they cost well over $2,000, plus nearly $130 sales tax. The entire overhaul cost the owner $3,400.

For $3,400 the owner got a rejuvenated engine, crafted by a local mechanic he knew and trusted. With proper run-in and careful use the engine is fully capable of reaching the factory recommended 1800 hour TBO.

Had he chosen a factory remanufactured engine, he would have paid $4,572, plus $297.18 sales tax. A factory-new engine would have cost $7,168, plus $465.92 in sales tax. Both prices would have been for exchange engines, but since the core was sound there would have been no additional cost.

By choosing a field overhaul, this engine's owner saved himself $1,469.18 from the price of a reman, $4,233.92 from the price of a new engine. At a Cessna 150's specific thirst, that pilot saved enough money to buy gas for between 200 and 530 hours of flying. That's a rewarding decision. •