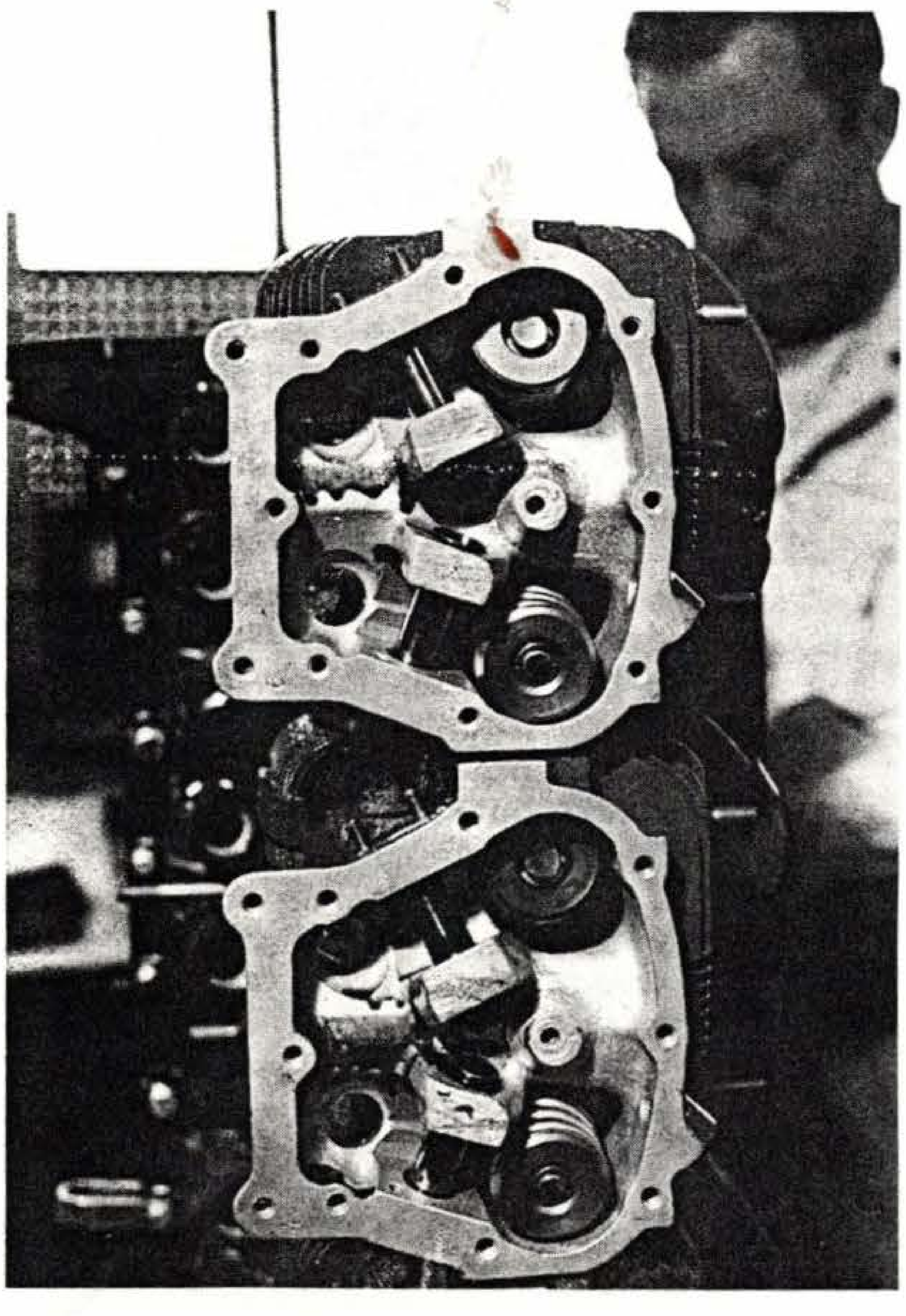
Common Overhaul Mistakes (and How to Survive Them)

by Kas Thomas

No shop likes to admit it makes mistakes, but all do at one time or another—even the so-called premier overhaul shops (you know the names; I don't have to list them). In fact, there's been a good deal of consternation lately among IA mechanics—and owners—about the caliber of slip-ups that have occurred in engines recently overhauled by supposedly top-quality shops. One well-known East Coast overhauler is backpedalling vigorously in an attempt to re-establish its good name in the engine-rebuild business (after a disappointing episode under big-company ownership). Another firm, known for custom cylinder work, is bailing water furiously to hold back a sea of cylinder-cracking claims. Even the engine manufacturers aren't above suspicion. Zero-time factory remans occasionally come with low oil pressure or poor oil consumption. (Our favorite story involving a reman is the one about the TSIO-360 that had a drill bit in the accessory case.)

Some percentage of warranty returns is unavoidable, in *any* business. But nothing sours a customer/merchant relationship like a blown jug at 13,000 feet over Lake Michigan (or a \$20,000 bill for an engine that's burning a quart of mineral oil an hour at 10 hours SMOH).

Things are seldom as dramatic or cut-and-dried as a blown cylinder, however, or quart-an-hour oil consumption. Often, overhaul-related problems don't show up for 100, 200, even 500 hours. (See the accompanying story by the Cherokee owner whose exhaust valve took *two years* to break.) And what if oil consumption stabilizes at a quart every *three* hours? Or a quart every *four* hours?



Lycoming engines come in parallel-valve and angle-valve cylinder head types. The IO-540 shown at left has angled valves. Not only are the valves themselves different in the two engine types, but the guides they use are different—and easy to mix up, with potentially disastrous results (see story on page 16).

Where does one draw the line on overhaul snafus? What are the rebuilder's responsibilities? The customer's remedies?

More important: What, exactly, *are* the most commonly made overhaul mistakes—and how can they be diagnosed before they cause serious (read: NTSB-reportable) trouble?

Top-End Mayhem

Overhaul foulups can conveniently be divided into top-end and bottom-end troubles. Typical top-end snafus would include things like poor or no cylinder honing, defective chrome-plating, and/or sloppy buildup of components (inattention to gaps and fits, poor attention to cleanliness, etc.); while bottom-end mischief would take in such no-nos as putting normal-size bearings on an undersize crankshaft (for example), or doing a careless job of silk-sealing the case halves (which—believe it or not—still happens, even at the factory).

A favorite "old saw" has it that one of the most common top-end overhaul mistakes is installing rings upside down. But this is largely myth. The fact is, unless you have an old-style O-470 (or E-225 Continental) with rectangular-cross-section piston rings, or one of the very few Lycoming models with full-wedge (double bevel) rings, it's very difficult—we won't say impossible—to physically force a half-wedge piston ring upside down into its groove, *and most piston rings are half-wedge*. The part number marking (indicating the ring's top side) is inked on the side of the ring that is supposed to face *away* from the crankcase parting plane. But really, even Stevie Wonder could assemble a set of half-wedge compression rings to a piston and get it right the first time. It's the square-peg-goes-in-square-hole principle.

In fairness to mechanics and overhaulers: Many *wiper* rings and rectangular-section *compression* rings *will* easily fit into the groove upside-down. (Note for Lycoming owners: On the O-235 and chrome jugs, the craper ring is installed scraper-edge-up; on all others, the scraper edge is installed toward the bottom of the piston.) And there have been many (repeat: more than a few) cases of ring vendors mistakenly marking the part number on the wrong side of the ring! (If you're wondering why it makes a difference: Wipers and compression rings are beveled at the outer face—where they meet the cylinder wall—and if the bevel isn't oriented right, oil control suffers.) But the notion that a large proportion of overhaul problems in General Aviation today involves upside-down rings is—need we say?—demonstrably false.

Fortunately, most overhaul errors are top-end or cylinder related and do not involve safety of flight. Sloppy honing, grinding, and chroming are common.

Let's look at where the real troubles are. Common top-end mistakes include:

1. Inadequate or poorly controlled barrel microfinish (hone), often with accompanying change of choke profile. (Applies mainly to steel cylinders.)

2. Poor asperity in chrome-plating. (Obviously, this applies only to chrome jugs.) Rejection rates of 30% . the cylinder chroming business are routine. That is, up to a third (or so) of all jugs that come out of the chromic acid vat end up getting sent back through for rechroming before being released to the customer, because the chrome channeling wasn't right the first time. Unfortunately, there's not much a plane owner can do to guard against improper chroming, except to deal with a large, experienced shop (hint: chroming was invented in San Antonio, so Schneck and ECI suggest themselves) and hope for the best. Be sure to avoid lengthy ground idling during break-in and *fly the engine hard.* If oil consumption isn't a quart in six hours (or better) at 50 hours, don't expect it to improve dramatically in the next 500. Ask your overhauler what he intends to do if your oil consumption is still poor at 100 hours.

3. Chrome rings in chrome jugs: This old bugaboo is *not* myth. It happens all the time. (And it destroys engines.) Be absolutely certain that a chromed jug gets plain cast-iron rings, not chrome-faced rings.

4. Failure to check dry tappet clearance (and compensate for discrepancies with appropriate-length pushrods). This is particularly important in engines that have had crankcase lapping performed—or valve seats replaced—multiple times in the past. Why? Case lapping removes metal and brings cylinder hold-down pads (hence the cylinders themselves; hence the heads; hence the rockers) closer to the centerline of the camshaft, taking up valve train lash. Likewise, deep seats (and shallow seats that have been made deep by cutting or grinding) increase the valve depth and take up lash.

"Heck, we've seen O-320s that wouldn't go back together right—the valves would be up off the seats—because the case had been lapped so many times," a spokesman for a large crankcase shop once told us. "We're working on an FAA-approved process right now to reverse that trend—to add metal back between the case halves prior to line-boring." (You can bet this shop wouldn't be working on such a salvage process if the problem weren't serious to begin with.)

5. Careless valve, seat, or guide grinding/reaming. Consult "The Engine Clinic," August '88, for further information on this topic; also see Lycoming S.I. 1200. Suffice it to say, a lot of shops are in the habit (still) of installing guides without truing them to the seat centerline, then piloting off the guide when grinding the seat. The lack of concentricity between seat and guide centerline is, in many cases, startling; the off-center seat cut is obvious on visual inspection. "Ah, that won't hurt anything, it just looks bad is all," many shop hands will say. Three hundred hours later, the customer is back in for a valve job. You be the judge. We like to see guides and seats made concentric to each other (by line-boring), and leave the piloted-seat-grind technique to the corner garage.

Ditto for hand-held hones. When we see a motorized porcupine in a so-called "premier shop," it gives us the willies. A contoured hone (with a big Sunnen) is the only way to preserve choke profile and achieve a breakin-worthy microfinish, and even then, the end result is highly operator sensitive. The cross-cut should be visible, and visibly equal in each direction, preferably at 30 degrees to the barrel bottom (although some operators prefer 45 degrees), and not so rough that a fingernail can feel it. It should *look* sharply cut, but feel smooth and test out at 25-35 microinches RMS.

Bottom-End Blues

Happily, the majority of overhaul foulups involve the top—rather than the bottom—end of the engine (and thus are, relatively anyway, easy to correct). But a good deal of bottom-end mischief still gets perpetrated (unintentionally, of course) in the overhaul industry. One of the most

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famous episodes of recent times was Continental's substitution of castor oil for mineral oil as a thread lube on the crankcase through-studs of the TSIO-520-BE engine, which resulted in the target torque being reached on the nuts before the desired stretch (tension) was reached on the studs. Unfortunately, several customers' main bearings spun (and several Malibu engines lunched) before the problem was detected and fixed on the assembly line. Meanwhile—perhaps only coincidentally (heh heh)—Piper went elsewhere for engines.

Some of the more common bottom-end snafus include:

1. Unskilled application of sealant to case parting halves, giving rise to a leaky engine at short time. Many shops, in accordance with Lycoming Service Instruction No. 1125, have abandoned '00' silk thread and POB No. 4 sealant for RTV-102 (sans thread) as a case sealant, for the most part with good results. But wanton application of RTV can lead to a permanently leaky engine and an expensive-to-fix warranty problem. There is no easy way to "patch" a breach in RTV.

2. Improperly ground (or re-hardened) tappets and/or camshafts. This is a fairly common problem, and it can be horrendously expensive to fix. (Also, it may take years to show up.) Be sure the shop that regrinds your cam or lifters has FAA approval to do so, and be sure to grill the overhauler on *his* policy in case of cam destruction at, say, 300 hours. The

A Tale of Two Engines

by E. Jeff Justis

What a beautiful overhaul we had just completed on our two TIO-540-C1A Lycomings: After 1,682 hours, all cylinders had good choke, and the crankshafts, unbelievably, were still within new limits. We replaced all pistons, valves, exhaust guides, hoses, and gaskets. Every accessory was rebuilt. Props were factory-remanufactured. Hoses were renewed. Even the Adel clamps were replaced with brand-new. In short, we'd produced two engines as close to new as a field overhaul by a pilot-A&P and his IA buddy could hope to accomplish. (My IA has an excellent reputation as an engine man.) We were both justly proud as we flew an uneventful test flight.

To more thoroughly break in the Turbo Aztec's engines, a two-hour flight to Knoxville was undertaken. Performance was flawless. A little adjustment in the right engine's density controller might be needed, but that's par for the course. (It'd be odd if such an adjustment *were'nt* needed.) All else was nominal.

Two days later, I made another delightful two-hour flight, this time from Knoxville to Destin, Florida. My pride and confidence were growing with each flight. After a good lunch on the beach, and with my son flying left-seat, we departed Destin for Memphis.

"Boy these engines are running smooth," I thought to myself as we levelled at 10,000 over Tuscaloosa. "But what's that little roughness that just started?" It was barely noticeable. But definitely there.

Next came a little drop in manifold pressure. I quickly began to flip through the EGT analyzer. The left number-six cylinder was cold. Manifold pressure was decreasing more, and the roughness was becoming more pronounced. Checking the mags individually, I could find no difference. We flew on, trying to analyze the situation in calm, collected fashion (while we had the chance); then the engine began to surge as the automatically controlled wastegate tried to compensate for the loss of manifold pressure. *[Probably, the wastegate was slowly closing, the whole flight. When it fully closed, a high-gain feedback loop was set up, and bootstrapping began in earnest.—Ed.]* Reducing power stopped most of the surging. But I didn't feel we could limp another 120 miles to home base, and so a landing was made at Tuscaloosa.

Trouble

Removing the left nacelle side panels, a quick look at the number-six jug revealed the problem: The rocker arm cover was torn, leaking oil. On removing the cover, the rocker arms were hanging free with the rocker arm bosses broken off! Inspecting the valve stems, and looking the cracked area over closely and discussing it with the local IA, it was our consensus that what we were looking at was the result of a fatigue crack that had been present for years and perhaps with the increased power following major overhaul, it had finally been overstressed and broken. Since we hadn't replaced the rocker arm shaft bushings, we didn't feel at all responsible for the mishap. (We didn't touch anything that could have messed it up.) After calling around the country, we finally located a serviceable steel-barrel cylinder that could be shipped to us within a couple of days. We went home by rented 172, and came back three days later.

Back in the air ion the Aztec, on our way to Memphis again, the engines purred along with the silky smoothness that we expected. I was flying left seat this time. About halfway to MEM, my son nudged me and pointed to the right engine. Streaks of oil were slipstreaming back along the cowling. "You think you may have left the oil filler cap loose when you checked the oil?" I asked, hoping (of course) that that simply explanation was the answer. "No, I don't think so," my son replied. I then realized that he was probably right, because as a naval flight officer, my son has trained to be rather thorough in his preflight.

Flipping through the EGT channels, this time we could see it was the number-three cylinder of the right engine. "Man, we've got a problem!" I said. Actually, there was very little change in manifold pressure on the right, and except for the leaking oil and absence of EGT indication in the number-three cylinder, there was no major problem (no surging, for example), and so we continued the short distance to home base.

After landing, the problem was readily apparent. The exhaust pushrod safest course of action, naturally, is to insist on 100% new parts. (There isn't a shop in the country that will use reground lifters on an O-320-H Lycoming, even if you want them to.) It's also the most expensive course of action.

3. Main bearings too tight. Ask your shop if they use a dye or film-squeeze assembly-fit technique to judge (and adjust for) bearing pinch problems on buildup. (Hopefully, they do.) Also, do they shoot for the tight side, or for the loose side? An odd fact of life in the engine business is that when main bearing clearances are on the *loose* side, the engine puts out more power and has less chance of encountering bearing problems later in life. You'd think it'd be just the opposite, but it isn't.

4. Installing the wrong counterweight pins or bushings (or the wrong counterweights, period) on blade hangers, in engines that use dynamic counterweights. This is easier to do than you might think. For example, Continental at one time used two different counterweight P/Ns to achieve two different harmonic ranges of dampening in the O-470. When the P/N 633225 crankshaft came out, Continental decreed (in S.B. M83-4) that the *same* counterweight would be used for 5th-order *and* 6th-order dampening; tuning would be achieved by using *different P/N counterweight rollers*. Visually, the parts don't look much different and are easy to mix up. What happens when you put the wrong rollers in

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in question was badly bent and had deformed the pushrod shroud tube, cracking it open and allowing oil to leak. "What could cause this?" I wanted to know. My IA friend borescoped the cylinders and could find no sign of trouble. He speculated that mistiming of the mag initially may have caused some back pressure that could have resulted in a bent pushrod. Momentary sticking of a valve could also have been the culprit. We considered the likelihood (or lack thereof) of a hydraulic lifter problem. There was some question as to whether we had checked the dry tappet clearance accurately enough, for example, or whether the collapsed (dry) tappet clearance was out of limits. So after replacing the bent pushrod, all of the hydraulic lifters were rechecked for clearance. Everything was fine.

We couldn't for the life of us come up with an adequate all-encompassing explanation. Once again, we reassured ourselves that these two problems (the broken rocker bosses on the left engine and bent pushrod on the right) were not necessarily related and were, in fact, isolated instances.

More Mischief

One week after all this, we again took off confidently for Destin, FL. As Tuscaloosa slid under the wing, I thought to myself: "Well, we're past that problem point again and everything seems to be running well."

Just as I was thinking this, I felt—almost subliminally—what seemed to be a very slight roughness of the left engine again. Nothing major; just "autorough." But the EGT didn't lie: It was telling me I had a problem in the left engine again, this time the number-one cylinder. Soon, the telltale sign of oil streaking was evident on the cowl. This time, we were on instruments approximately 50 north of Destin. Some mules take three kicks before you can get their attention. This was my third kick. It got my attention. I knew I had a major problem, of some sort, with both engines. (Thank heavens I wasn't over water.)

After an oil-streaked approach and landing in Destin, I related my sad tale to the local IA. I was stuck. There was no way I could participate in the work on these engines in this situation; I would have to rely on somebody else.

Several days later came word from the IA that I had no fewer than six bent pushrods between the two engines, plus one freshly broken rocker arm and another starting to crack. The possibility of exhaust valve sticking was raised, and we discussed rehoning the exhaust guides without removing the cylinders (in accordance with Lycoming Service Instruction No. 1425). My friend who had done the cylinder work had a hard time believing that the valve guides were not adequately sized for the valves, or that they had deposited up in so short a period since the major.

Meanwhile, the left number-six cylinder—the one pulled for exchange after the first incident—had arrived at AERO Aviation in Granite City, Illinois. "I found your problem," Pat McNamara said over the phone. "Wrong valve guides."

Crucial Difference

It turns out that Lycoming *angle-head* valve guides, P/N 75838, had been put in the cylinder instead of the parallel-valve P/N 74230 guide. (The TIO-540-C1A uses parallel-valve cylinder heads.) The difference between these two parts? The angle-head guide is a quarter-inch longer on the rocker arm (top) side than the parallel-valve counterpart. What this means (if you get them reversed, as I did) is that each time the valve is depressed, the spring keeper bangs against the too-tall guide lip, creating stresses that feed back into the pushrod and rocker ears. Eventually, something's got to give: either the pushrod bends, or the rocker ears crack. Or both.

The question that kept going through my mind was: *How could this have happened?* Alas, a look at the Parts Catalog for the engine tells the story. The profusion of part numbers, lines, and columns easily leads to confusion. In the TIO-540-"wide" series, the -C1A is the only one using the shorter exhaust valve guides.

Who's to blame for this fiasco? I am, ultimately, because in undertaking a major overhaul, I should have checked all part numbers and dimensions before installation. My friend, the IA, feels *he* is responsible because he supplied the list of parts and also did not check the part numbers specifically and dimensions prior to installations. Perhaps there is a conspiracy by the engine manufacturers to create problems for a field overhauler through confusing parts lists and overhaul manuals. How easy it would be, in this day of computerization, to furnish up-to-date, serial-number-customized, engine-specific parts lists on request! Just think how nice it would be if an engine manufacturer could assist field-overhaulers in this way. Yet, it will probably be years before this is done.

For want of a proper valve guide, two engines were almost lost. For want of an engine, the airplane itself could have been lost. Let every pilot—A&P rated or not—understand that regardless of intentions, whenever humans are deeply involved in the process, human mistakes can and will be made.

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The Top-End Time Bomb That Took Two Years to Show Up

We had a recent experience with Lycoming sticky valves, but with a new variation to the story—one well worth noting if you're fresh out of an overhaul, or about to go in for a major.

The incident was set up a couple of years previously, back in 1986, when I had a mechanic check the valve guide clearances and replace some leaky pushrod shroud seals during an annual inspection. The engine is a 150-hp low-compression-ratio Lycoming O-320-E2A which burns 80 octane fuel. It has had a steady diet of 80-octane avgas, with 100LL used only occasionally (and then with TCP added).

I was flying my 1966 Piper Cherokee over the Mojave Desert enroute from Las Cruces, New Mexico, to Visalia, California. Earlier, I had made a fuel stop at Apple Valley, east of Palmdale, where I filled up with 80 octane avgas. I was now just approaching the Tehachapi mountains in Southern California, northwest of Palmdale, west of Edwards Air Force Base, when a "CLANG-*crump*" sound came from the engine. The loss of power was immediate and was accompanied by much vibration. At the time, I was at 8,700 feet MSL and 17 nautical miles northwest of Rosamond Skypark. I pulled back the throttle and the vibration stopped. Slowing to best glide speed, I initiated a 180-degree turn and glided to an otherwise uneventful power-off landing at Rosamond Skypark (thanks in part to a 25+ knot west wind).

Within an hour after landing, the faulty cylinder was isolated and the cause of the incident determined. The number four cylinder's exhaust valve had broken and the valve face was folded in half and jammed into the lower spark plug hole. The mechanic said the exhaust valve guide had been "working" in the cylinder head for a while.

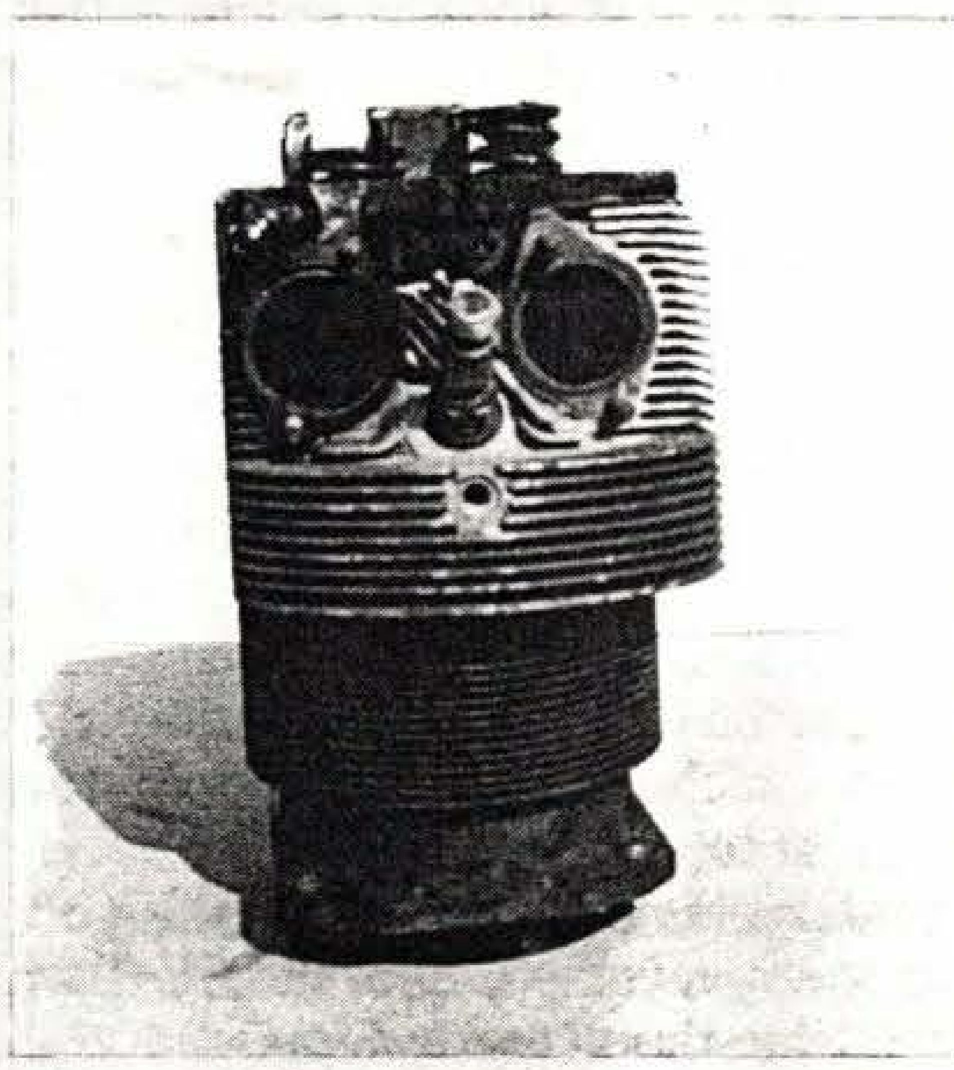
So far this sounds like the typical valve sticking scenario, right? But guess what? The mechanic also found that the intake and exhaust rocker arms had been interchanged!

The exhaust valve rocker arm on the Lycoming O-320-E2A engine has a passage drilled in it to cause oil carried by the hollow pushrod to be squirted on the exhaust valve stem to cool and lubricate it. The intake rocker arm, by contrast, is *not* drilled. Well, on this engine those two rocker arms had been swapped so that the intake valve was getting a good dose of oil, while the exhaust valve (served by an undrilled rocker) got none.

Luckily, when the valve broke, the piston didn't get holed and no big parts got past the piston rings. Also there were no missing pieces of any significant size that were not accounted for, such as lost in the intake manifold or another cylinder. The cylinder was deemed rebuildable by the overhauler and I even got my core deposit back on a replacement cylinder. Fresh Aeroshell mineral oil was put in and a new oil filter put on. The whole repair cost a total of $1,400. Many thanks go to Aronson's Aircraft Service for treating me so superbly at Rosamond, including a free drink at a local bar after landing. (Thanks, I <u>really</u> needed that!)

Fifteen hours after the cylinder replacement, and back home again, the oil filter was removed and inspected for metal parts. There were aluminum looking particles the size of popcorn salt inside. The particles, when spread out, covered the tip of my index finger. There was nothing metal in the oil pump screen, just two small chunks of carbon. It looks as though nothing else drastic has occurred to the engine and I now have nearly 50 hours on it since the number four cylinder was replaced and have passed another annual inspection as well.

As part of my preflight each time before starting, I now make it a habit to pull the propeller through four compression strokes to see (or feel) if the compression on all the cylinders is normal. Once, I thought one cylinder felt "soft," back in August, 1987, but only that one time. *[The valve guide had probably pulled loose at this point.—Ed.]* The engine has never ever run rough, either at start-up or any time. That one preflight months before the final demise of the valve was the only warning I had.



The 100-hour (or rather, annual) inspection done by the mechanic at Denver two years and 200 hours previous was probably the occasion on which the rocker arm swap occurred. I recall at the time the mechanic telling me that the rocker arms on my number four cylinder were interchanged and he was going to straighten that out for me. It was a sincere gesture, and I suppose he was thinking that the exhaust valves are toward the front of the engine. That is true on the right side of the engine, but not on the left side. (He's probably a good guy to call if you have trouble on the right half of your engine, if you can find him.) But at least the pushrod shroud seals didn't leak any more when he was done, and I had (false) peace-of-mind in believing the valve train was in good condition. (The mechanic and the shop who did the work on my aircraft in Denver are now out of business, so there is no recourse to them.)

Just two months before the valve-eating incident, I and my wife, and two small children, had just completed a 3,400-nautical-mile round trip from New Mexico to Summerland Key, Florida. I am *oh-so-very-thankful* the engine did not choose to quit over Tampa Bay, or the Everglades. Or anywhere else.

The frightening part, to me, is the realization that with the exhaust valve *gone* in one cylinder, the engine just *will not produce meaningful power*. The picture that appears in my mind is that of the aircraft passing over the fence (or trees or buildings, as the case may be at your airport) on departure, and all of a sudden the valve bites it *then!* You have 25-percent (or less) power still available, perhaps you 're loaded to gross weight, and suddenly you're going down.

Not a pretty sight.—*Thomas Clemens*

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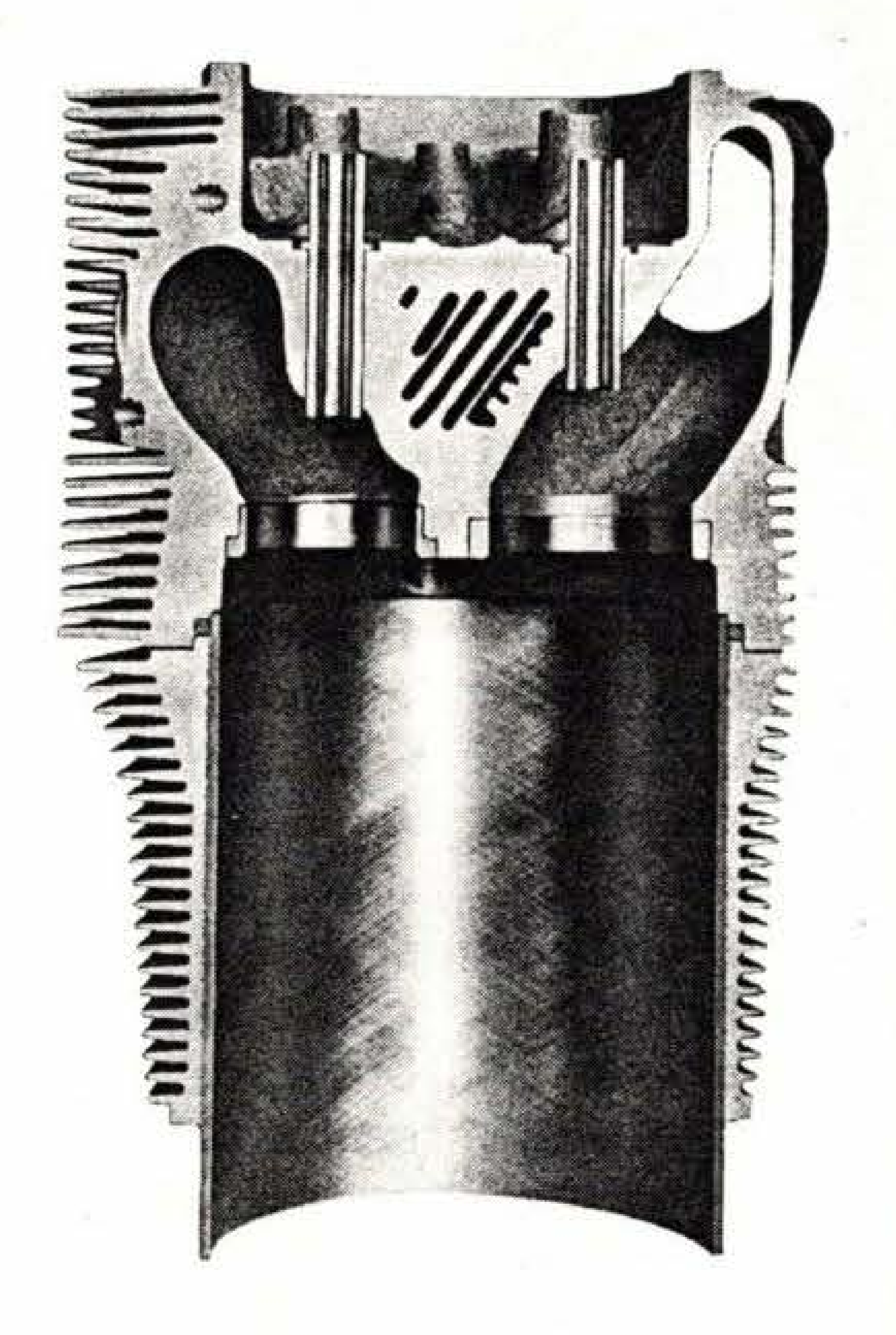
with the wrong counterweights is that your O-470 (or IO-470, or sandcast IO-520) starts throwing alternator belts on every flight, usually just after takeoff. Or your big Lycoming may start going through prop spinner back plates like there's no tomorrow. Brackets may start to crack for no reason. Your hair may begin to thin, too, before you figure out that somebody, somewhere along the line, installed the wrong-frequency counterweight pins. (In some cases, the problem can be remedied without hoisting the engine and splitting the case, but it's no picnic.)

Oil Pressure Problems

Aside from high oil consumption associated with poor break-in (which in turn is usually a result of poor chrome asperity, insufficient choke, and/or problems with barrel microfinish, rather than poor operator technique during break-in), one of the most frequent post-rebuild complaints involves the oil *pressure* not reading where it used to. An owner of a Continental-powered Skyhawk who recently had his engine overhauled by a newly popular East Coast facility recently told us: "I've got 30 hours or so on it, and the oil pressure is nowhere near as high as it should be, or as it was before the overhaul. Odd thing is, it actually improves as the engine warms up. But it's not bad enough for the overhauler to do anything about it. I'm not really sure what to do."

A P-Baron owner remarked of his recently overhauled right engine: "The right [side] runs at lower pressure than the left, now, which it never used to. It's not out of the green—just noticeably lower. We think it may have to do with the pumpability of the oil. We're hoping it'll be different after we switch to Aeroshell Multigrade, which is what the left engine uses."

It's true that the pumpability characteristics of mineral oil are somewhat different (especially in cold weather) than those of a multigrade oil. Aeroshell 15W-50, in particular, has a reputation of being a "high oil pressure" oil, giving higher, more consistent oil pressure than, say, SAE 40 red-can Shell. This is not too surprising. Viscosity and pumpability are, after all, different properties. (Mayonnaise is viscous, but not pumpable. Soda is pumpable, but not viscous.)



A properly honed jug will have obvious 30- to 45-degree crosshatching, as on this parallel-valve TCM jug.

Still, few things are more upsetting than paying $10,000 or $15,000 for an overhaul ($20,000, if you happen to own a P-Baron) and finding out that your oil pressure is now *lower* than it was before the rebuild.

The answer is, first, be sure no carbon or sludge or metal chips from machining processes has covered over the oil pressure pickoff at the crankcase. Second, get off of mineral oil as soon as possible. Ring seating is 90 percent complete in the first hour of operation (if you ran the engine hard, that is; not if you sat on the ground idling). Switch to regular A.D. oil as soon as you feel oil consumption and cylinder head temperature have stabilized. This may be as soon as two or three hours after overhaul. (Chrome engines should probably adhere to an old-fashioned 50-hour mineral-oil run, but most others can ignore this time-honored break-in advice and switch to dispersant oil at 5 to 10 hours.) Take a look inside the oil filter (or screen) at the first oil change, incidentally. Save any metal that's present for later analysis.

If oil pressure is still unimpressive after switching to dispersant oil (preferably a multigrade), ask your overhauler to check or adjust the oil-pressure relief valve, which on most engines is adjustable either by placing washers under it or turning a slot screw and cinching an acorn nut. It's best to do this with a fresh oil filter in place, by the way. If the old one is full of oil or has a metal chip under its bypass valve, it could skew the results of your adjustments.

Should your relief valve adjustments not achieve the desired result (and especially if the oil temperature is running hot in conjunction with the low oil pressure), it's time to ground the plane and have a serious chat with your overhauler. Some types of engines—the Continental E-series and Lycoming IO-540 series come to mind—have two different flow-capacity oil pumps, and if the wrong one is installed, you'll have chronic low pressure. It's best to deal with this now, while the engine is young.

Of course, your overhauler—if it's a large, reputable outfit—will have run your engine in a test cell before releasing it to you. The test log should show what the oil pressure was in the cell, and it should fall squarely in the middle of the factory-specified range. If the pressure is markedly different with the engine mounted in your airplane, you're obviously looking either at a problem with your gauge, or a problem with your engine.

Again, the time to deal with this and most other potential overhaul flubs is *before* you sign the work order and hand over the keys. Talk with your overhauler about the "fuzzy zones" of warranty coverage—areas that aren't often spelled out clearly, like what happens if oil pressure is at the bottom of the green after 25 hours, or what the rebuilder is obligated to do in case of marginal oil consumption (which we define as anything worse than a quart in four hours). Find out who the "send out" vendors are for crank and cam grinding, cylinder chroming, and accessory overhaul. Get a feel for what the shop's recent success rate has been—by asking for names and phone numbers of recent customers. Ask what the shop has actually done for "problem engine" customers in the past. And if they say they've never *had* a problem engine—well, you know what to do next.