

TRAINING

LYCOMING PISTON ENGINE SERVICE SCHOOL

BY TOM BENENSON

I never took auto shop in high school. As a result, I've never really understood what goes on under the hood of a car. In the days when mine broke down frequently I'd raise the hood, cuss a bit, slam it shut and drive away. Can't do that with an airplane, so I've always felt I should know more about the engine under my Cardinal's cowl—what makes it tick and, more importantly, how I can make it keep on ticking. Now, after attending the four-day Textron Lycoming Piston Engine Service School, I do.

The Piston Engine Service School course is taught at the Kathryn W. Lumley Aviation Center, a modern facility at the Williamsport (Pennsylvania) Airport, by the Pennsylvania College of Technology, which offers a number of bachelor and associate degree programs and certificates in aviation maintenance and avionics. The school, which has been training aviation mechanics for some 60 years at the same location, became affiliated with Pennsylvania State University in 1989 and moved into its new \$6 million, 50,000-square-foot facility five years ago.

Although the four-day, 28-hour course qualifies as an IA renewal program under FAR 65.93 (a) (4), it's designed for

anyone—pilots, owners and operators, and A&P mechanics—who wants a better idea of what's going on in front of the firewall of their airplane. Classes are held to about 12 people and the wide variety of backgrounds of the other students adds to the experience. In the class I attended there was a dentist who flies a Cardinal and is building an RV-6; a father and son team of teachers who had built an RV-4; a retired United Airlines pilot who last flew behind a Lycoming engine in 1954; a member of the experimental department of Cessna's single-engine division; two investigators with the National Transportation Safety Board; and four mechanics who do actually work in the trenches.

James Doebler, head of the department, led us through a course that was carefully designed to move from the simple to the more complex; from a brief history of Lycoming engines through the availability and importance of publications to the nuts and bolts—literally—of crankshafts, crankcases, cylinders (connecting rods, piston assemblies), valve trains, camshafts, exhaust systems, oil systems, ignition systems, induction systems, fuel systems, and turbocharger systems. It became quickly obvious that

Doebler knows his way around Lycoming engines and how they best should be maintained.

As part of the tuition for the course, each student is provided with a full set of Lycoming Service Letters, Service Bulletins and Service Instructions and a year's subscription to them. A rack holding a set of the publications—about six inches thick—was set out at each table in the classroom and before long we were flipping back and forth between them.

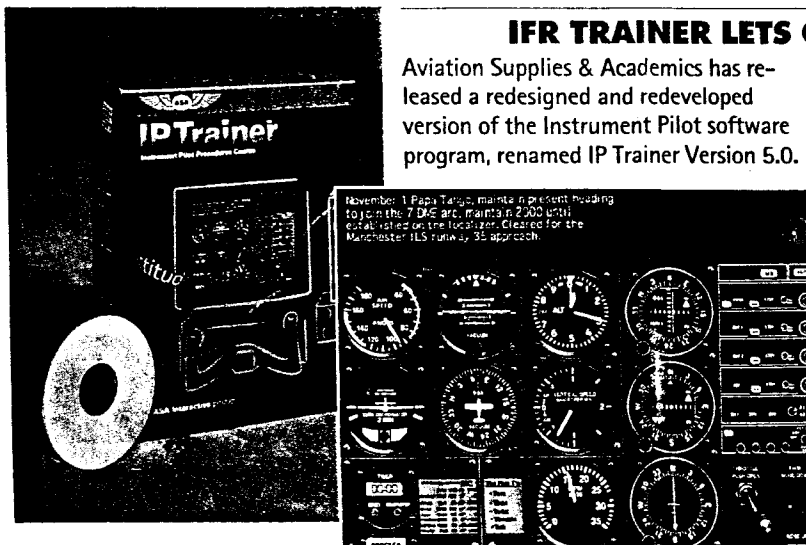
As Doebler explained, Service Letters serve as an introduction to Lycoming's new products and policy changes; Service Bulletins present a problem and the solution; and Service Instructions describe how to perform the task. "Service letters tell you what you *can* do, service bulletins tell you what you *should* do, advisory directives tell you what you *will* do, and service instructions tell you *how* to do it," Doebler said. The combined alphabetical index to the three different Lycoming publications made it easy to find specific references when Doebler cited them. And he frequently did.

At lunch on the first day, one of the four mechanics in the class complained to me that the course seemed too basic for him. Not for me. The next day he ac-

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Aviation Supplies & Academics has released a redesigned and redeveloped version of the Instrument Pilot software program, renamed IP Trainer Version 5.0.

Unlike other computer simulators, the program is designed to lead VFR pilots through 133 interactive lessons accompanied by a "virtual" instructor that demonstrates each maneuver, watches you practice, corrects you if you go wrong, and then tests you on it. The simulator features a Cessna 172 panel, realistic ATC voices, and lessons that include approaches in the New England area. The software package is accompanied by the Instrument Flying textbook by Trevor Thom. The program is priced at \$495; registered owners of earlier versions can upgrade for \$99.95. For more information call 800/ASA-2-FLY or 425/235-1500.



knowledgeable things had speeded up and he was learning a great deal, much more than he had expected.

There were times, with my lack of previous mechanical knowledge, that I felt lost. But Doebler was patient and his explanations and hands-on engine parts helped clear the murk. No question, he did get into details. Referring to the Service Instruction SI 1029 ("Tightening Procedures for Crankcase Thru-Studs and Bolts"), Doebler discussed the proper way to lube the studs with one of four approved lubricants and the correct sequence for torquing the studs to re-assemble the crankcase. To seal the case, he referred to SI 1125 ("Alternate Crankcase Parting Surface Sealants") and detailed the correct way to use "00" silk thread with POB No. 4 Perfect Seal. "These engines aren't hard to work on and maintain," he said, "but you have to pay attention to the little things like these—lubing the studs and getting the torque right."

As I sat in class, I kept wishing the mechanics that work on my airplane were sitting with me. I wanted to be sure that they learned—or were being reminded of—some of the things I was learning, such as the proper way to rotate spark plugs, which according to the SI should be done every 25 to 50 hours. It's not just a matter of moving the bottom plug—which tends to foul first—to the top of the cylinder. The mags produce AC current, so the sets of plug in each cylinder alternate between a positive flow and a negative flow, and the plugs wear in the direction the current is going through the plug (either ground to center or center to ground). If you just put the lower plug in the top spot of the same cylinder, the direction of the current through the plug hasn't changed and it will continue to wear in the same spot. On the other hand, if, on a four-cylinder engine, you rotate the top plug from the number one cylinder to the bottom of the number four cylinder and the plug from the bottom of the number four cylinder to the top of the number one cylinder, you change the polarity and the plugs will last twice as long. The four days were full of those kinds of hints and details.

Although designed for mechanics, the class discussions weren't only involved with maintaining the engine but also operating it, items especially important for pilots. As a pilot, how do you recognize valve sticking? "Morning sickness"

where the engine runs rough on the first start of the day; roughness on climbout or cruise; a "bump" that makes you wonder, "What the hell was that?"; high mag drops while the engine continues to run smoothly; roughness at idle—all are symptoms of valve sticking.

Doebler also listed some of the causes of valve sticking: dirty oil (moisture, acids, carbon); bad induction air filter ("throw away the sponge filter every time"); high cylinder temperatures; im-

proper leaning; incorrect overhaul procedures; and the wrong fuel or oil use. Although the exhaust valves are usually the ones that stick, Doebler insisted that all the valves in all the cylinders should be corrected. SI 1425 addresses the way to repair sticking valves.

From a pilot's point of view, SL L197, which offers recommendations to avoid valve sticking, is more useful. According to the Service Letter, the engine should idle at between 600 and 650 rpm but the



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warm-up and waiting for takeoff should be done at engine speeds of between 1,000 and 1,200 rpm. At those speeds the spark plug core temperatures are hot enough (above about 800° F.) to activate the lead scavenging agents contained in the fuel, which retards the formation of lead salt deposits on the spark plugs and exhaust valve stems. The Service Letter also recommends that "prior to engine shut-down, the engine speed should be maintained between 1,000 and 1,200 rpm

until the operating temperatures have stabilized. At this time the engine speed should be increased to approximately 1,800 rpm for 15 to 20 seconds, then reduced to 1,000-1,200 rpm and shut-down immediately using the mixture control."

In discussing lubricants and lubrication, Doebler said it's common to find a few flakes of metal in the oil filter. How much metal is alarming? "A rule of thumb," he said, "is, if there's enough metal to cover your thumbnail, there's

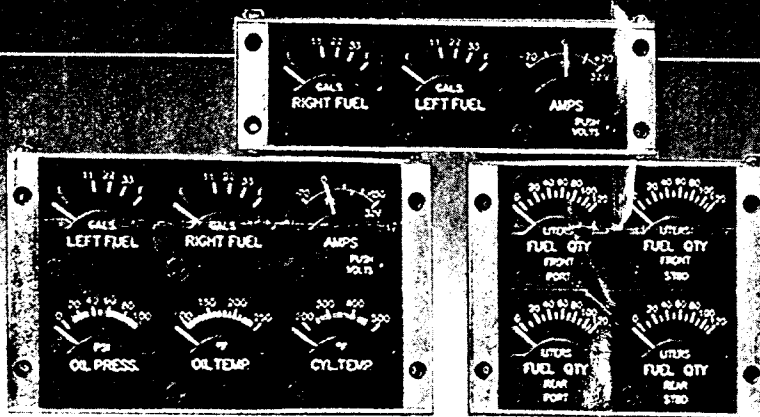
something to worry about." Oil change intervals are recommended in SB 480, and SI 1014 lists the oils that Lycoming recommends for its engines.

By the end of the course the value of the publications as reminders and instruction books for virtually everything that should or must be done to Lycoming's engines was obvious. Items are cross-referenced in the index, making it easy to locate desired subjects. I expect the year's free subscription will be well worth the price of tuition.

I didn't attend the Textron Lycoming Piston Engine Service School to learn how to put an engine together or to become a mechanic. But by the end of the course I had a pretty good idea of what parts went where and what they did. Tuition is \$440 and includes all course materials and the one-year subscription to all Textron Lycoming service bulletins, letters and instructions. The school has negotiated a special rate with a nearby hotel that includes transportation back and forth from classes. Courses are held roughly twice a month. For a schedule of classes or to register call 717/327-4775; fax 717/321-5546.

On the other hand, if you do want to become a full-fledged mechanic, the Pennsylvania College of Technology has several programs that will get you there. For information about the college's career courses, call 800/367-9222 or 717/327-4761, or visit <http://www.pct.edu>. □

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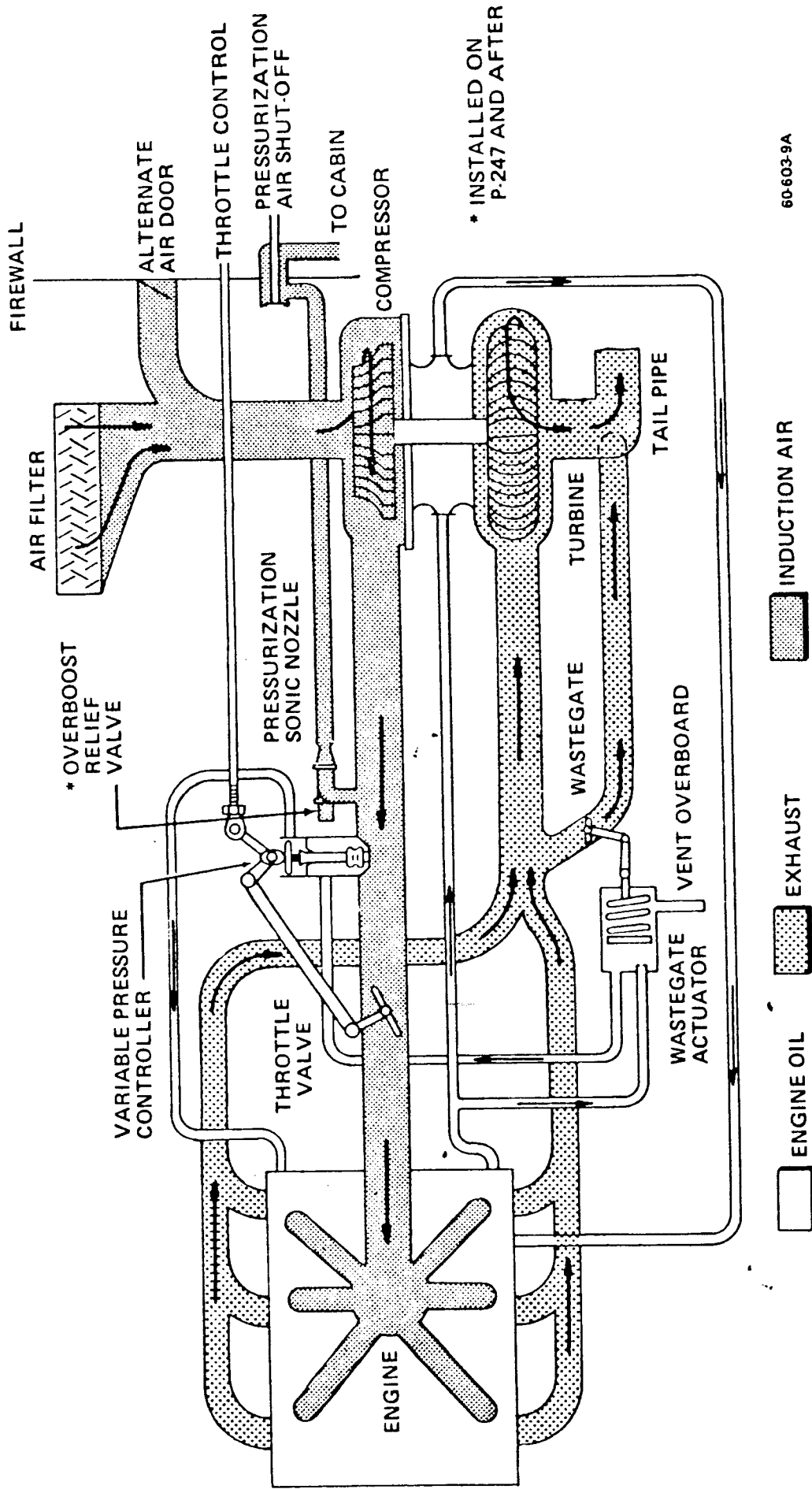
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SCHOLARSHIP WINNERS AND APPLICATION DATES

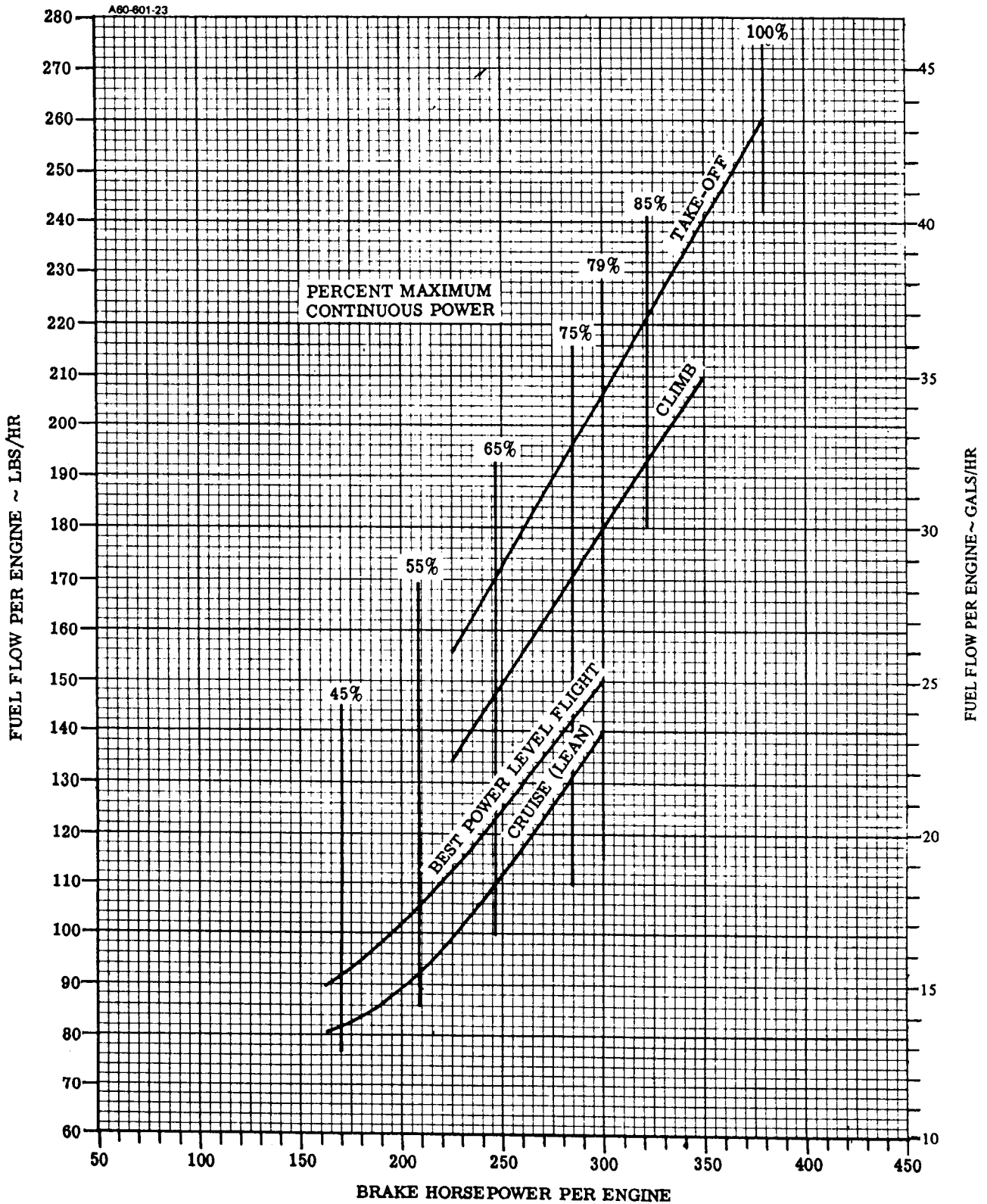
The 1998 McAllister Memorial Scholarship was awarded to Rebecca D. Johnson, a senior majoring in aviation at San Jose State University, and the 1998 Burnside Memorial Scholarship was awarded to Kara A. Kahler, a senior at Embry-Riddle. The scholarships, administered by the Air Safety Foundation and the University Aviation Association, are awarded annually to selected college juniors or seniors enrolled in a curriculum leading to a degree in aviation who have maintained a grade point average of 3.25 or better (on a 4.0 scale). Applications for the 1999 McAllister and Burnside Scholarships are available from the AOPA Air Safety Foundation, 421 Aviation Way, Frederick, Maryland 21701; you must send a self-addressed stamped envelope with your request. Applications must be received by March 31, 1999. □

BEECHCRAFT
DUKE 60 SERIES
MAINTENANCE MANUAL



Turbocharger System
Figure 1

FUEL FLOW vs BRAKE HORSEPOWER



APPROVED ENGINE OILS

(ASHLESS DISPERSANT OILS)

COMPANY	BRAND IDENTIFICATION
Delta Petroleum Company Incorporated	Global Concentrate A
Enjay Chemical Company	Paranox 160 and 165
Mobil Oil Corporation	RT-451, RM-178E, RM-180E
Shell Oil Company	Shell Concentrate A Code 60068 Aeroshell W120 Aeroshell W80
Texaco Incorporated	TX-6309 Aircraft Engine Oil Premium AD120 Aircraft Engine Oil Premium AD80
American Oil and Supply Company	PQ Aviation Lubricant 753
Chevron Oil Company	Chevron Aero Oil Grade 120
Humble Oil and Refining Company	Esso Aviation Oil E-120 Enco Aviation Oil E-120 Esso Aviation Oil A-100 Enco Aviation Oil A-100 Esso Aviation Oil E-80 Enco Aviation Oil E-80
Standard Oil Company of California	Chevron Aero Oil Grade 120

The vendor products appearing in this table have been selected at random to help field personnel determine products conforming to the specifications in this publication. The brand names are listed for ready reference and are not specifically recommended by Beech Aircraft Corporation. Any product which conforms to the referenced specification may be used.



Why an Overhaul from the Lycoming Factory?

There is no better overhaul for your Lycoming than a genuine factory overhaul. After all, we built your original. Our parts are genuine Lycoming, our labor is genuine Lycoming...backed by 60 years of experience building piston aircraft engines for more than half the general aviation aircraft in the world.

To help reduce your cost of returning an engine to airworthy condition, existing engine parts that meet Lycoming's *service allowable limits* are reused where appropriate. There is however, an automatic throw-it-away-and-replace-it policy for any part that doesn't measure up. Specified critical parts are replaced with new parts, no questions asked.

Product Improvements.

Any product improvements developed by Textron Lycoming after the engine was originally produced will automatically be incorporated at no additional cost to you. Your engine will be updated to the latest configuration required by all Lycoming Service Bulletins and FAA Airworthiness Directives.

Accessories.

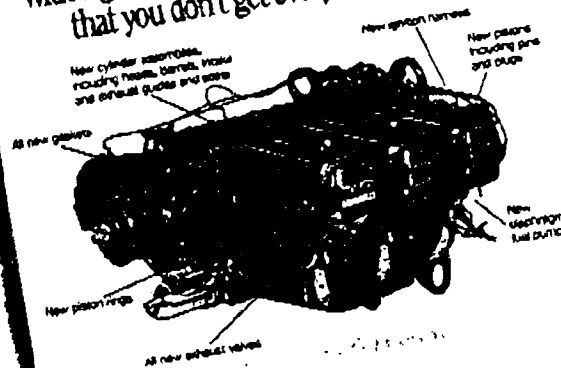
All Lycoming overhauled engines get the standard acces-

sories included by Lycoming when the engine was new. The fuel metering system, ignition system and starter are included in the overhaul price. Where applicable, the turbocharging system, alternator, engine-driven fuel pump and provisions for pneumatic and hydraulic pump drives are included.

Your engine is reassembled with new cylinder assemblies (barrels and heads), pistons, piston pins and plugs, rings, exhaust valves, guides, seats, seals, gaskets and many other new Lycoming parts not normally installed by other overhaulers.

There's another benefit to a genuine factory overhaul: Your engine is capable of running to its recommended TBO again...backed by a Lycoming factory warranty for a full year from the time you fire it up, regardless of the number of hours flown. Parts and labor. And, your warranty will be honored at any authorized Textron Lycoming Distributor at more than 150 locations world-wide.

Here's what you get with a genuine Lycoming factory overhaul that you don't get everywhere else.



There's more.

- ☐ All fuel valves
- ☐ All engine oil filter
- ☐ All oil seals
- ☐ All cylinder head nuts
- ☐ Hydraulic pump & hoses

- ☐ Overhaul throughout overhaul
- ☐ Overhaul in laboratory
- ☐ Inspected and certified
- ☐ Complying with FAA & FAA
- ☐ All service people

- ☐ All valves cleaned & seated
- ☐ All right and wrong valve
- ☐ All fuel transfer valves in working

Not every overhauler gives you that much. All brand-new, too. And, Lycoming uses only factory-engineered replacement parts in an overhaul, the only parts that match our original equipment specs...time-worn components that have been constantly improved through on-going R&D. The cost to you for the improvements? Absolutely nothing.

One more thing. You don't have to send your engine to the factory to overhaul. We've got engines ready to ship, so you can exchange yours here of ours.

For our new Piston Engine Data Pak, and the Lycoming distributor near you, call 1-717-323-6181.

TEXTRON Lycoming
Headquarters: Textron Lycoming, 652 Oliver Street, Williamsport, PA 17701

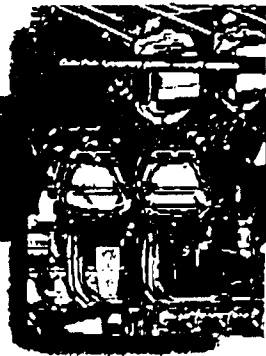
For pricing and availability, contact the Lycoming Distributor in your area, or our Sales Department, 652 Oliver Street, Williamsport, PA 17701.

Footnote: The term "overhaul" is used by Textron Lycoming to describe a piston engine category. This definition is not intended to contradict any authorized maintainer or publication regarding Lycoming engines or any FAR or FAA authorized publication.

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 652 Oliver Street, Williamsport, PA 17701



Remanufactured Engines.

The remanufacturing of a Lycoming piston engine can only be performed at the Lycoming factory. The immediate benefit of a reman is that the engine – and its logbook – are "zero-timed." They both start from scratch.

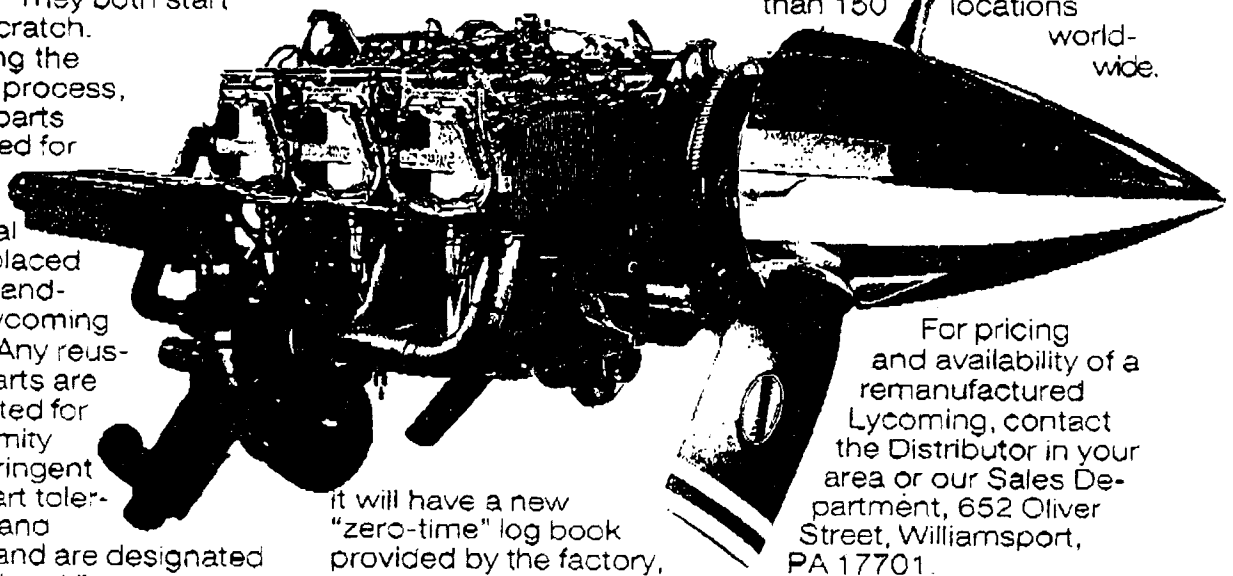
During the reman process, those parts specified for automatic removal are replaced with brand-new Lycoming parts. Any reusable parts are inspected for conformity with stringent new part tolerances and limits, and are designated "zero-timed."

The engine is reassembled with new cylinder assemblies (barrels and heads), pistons, rings, exhaust valves, intake valves, guides, seats and many other new and designated "zero-time" parts. Then – just as with a new

engine – it's tested to factory specifications to be sure it's up to the performance standards of a new Lycoming.

When your remanufactured Lycoming is installed,

and regular maintenance has been performed... and the factory will be at any Textron Distributor than 150 locations world-wide.



it will have a new "zero-time" log book provided by the factory, and the same warranty and recommended TBO as a new Lycoming engine.

As added long-term benefits... your remanufactured engine will be capable of being overhauled when it reaches TBO, provided normal operating procedures have been followed

For pricing and availability of a remanufactured Lycoming, contact the Distributor in your area or our Sales Department, 652 Oliver Street, Williamsport, PA 17701.

Footnote: The term "remanufactured" is used by Textron Lycoming to describe a piston engine category. The definition is not intended to contradict any authorized manual or publication regarding Lycoming engines or any FAR or FAA authorized publication.

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MANDATORY**SERVICE BULLETIN**

DATE: November 20, 1995

Service Bulletin No. 240N
 (Supersedes Service Bulletin No. 240M)
 Engineering Aspects are
 FAA Approved

SUBJECT: Mandatory Replacement of Parts at Normal Overhaul

MODELS AFFECTED: All Textron Lycoming reciprocating aircraft engines.

TIME OF COMPLIANCE: At overhaul.

During overhaul of any Textron Lycoming reciprocating engine, it is mandatory that certain parts be replaced, regardless of their apparent condition. The following is a list of parts that must be replaced.

- All engine hoses
- All engine hose assemblies
- All oil seals
- All cylinder base seals
- All gaskets
- All circlips, lockplates, retaining rings and laminated shims
- Piston rings
- Piston pins*
- Piston pin plugs
- Propeller governor oil line elbow**
- Propeller shaft sleeve rings
- Pinion shaft rollers (reduction gear pinion cage)
- Propeller shaft thrust bearings (all geared drive engines)
- Supercharger bearing oil seal (mechanically supercharged series)
- All exhaust valves (replace with current exhaust valves)
- All intake and exhaust valve guides
- All exhaust valve retaining rings
- Rocker arms and fulcrums (O-320-H, O, LO, TO, LTO-360-E series)
- Aluminum push rod assemblies (O-235 and O-290 series)
- Hydraulic plunger assemblies (except P/N 78290)



- All bearing inserts (main and connecting rod)
- Cylinder fin stabilizers
- Magneto drive cushions
- Thermostatic bypass valves
- Stressed bolts and fasteners, such as:
 - Stationary drive gear bolts (reduction gear)
 - Camshaft gear attaching bolts
 - Connecting rod bolts and nuts
 - Crankshaft flange bolts
 - Crankshaft gear bolt
- Damaged ignition cables
- Crankshaft sludge tubes
- Counterweight bushings in crankshaft
(See latest edition of Service Instruction No. 1142 for instructions)
- Accessory drive coupling springs (supercharged and VO-540 engines)
- AC diaphragm fuel pumps
- Oil pump bodies (two-piece)
- Oil pump gears
(Reference latest editions of Service Bulletin No. 524 and Service Instruction No. 1164)
- All V-band couplings and gaskets

Requirements for replacement of parts for accessories such as magnetos, carburetors, fuel injectors, AN fuel pumps, and turbochargers are described in the applicable manufacturer's manual.

* - Heavy-wall piston pins P/N LW-14077 and P/N LW-14078 may be reused; all others should not be reused. See latest edition of Service Instruction No. 1340 and No. 1267 for replacement data.

** - P/N MS20822-6D aluminum propeller governor oil line elbow must be replaced with P/N MS20822-6 steel elbow at overhaul. It is not necessary to replace a steel elbow. (Reference latest edition of Service Instruction No. 1435 and Service Bulletin No. 488.)

Dimensional inspections should be carried out in accordance with measurements and tolerances as listed in "Table of Limits" (SSP-1776) for all parts approved for reuse.

NOTE: Revision "N" updates parts that must be replaced at overhaul.

16503, 21043 - These numbers for Textron Lycoming reference only.

Here's what you get with a genuine Textron Lycoming remanufactured engine.

- New cylinder heads & barrels.
- New pistons & rings.
- New piston pins and plugs.
- New valve guides & seats
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- Automatic replacement of all items listed in our Service Bulletin #240: From oil hoses and seals ... to bearing inserts and counter-weight bushings ... and everything in-between.
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- The same factory warranty as a new Lycoming engine with world-wide support.
- New "zero-time" log book.
- Same recommended TBO as a new Lycoming.

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- New exhaust valves.
- Automatic replacement of all items listed in our Service Bulletin #240: From oil hoses and seals...to bearing inserts and counter-weight bushings ...and everything in-between.
- Automatic replacement of any and all parts not meeting Lycoming's critical inspection standards.
- A full, one-year Textron Lycoming warranty with world-wide support.

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Phone# _____
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Phone# _____
Fax # _____

EXCHANGE ENGINE INFORMATION

Engine Position Single Left Front
 Right Rear
Model _____ Spec.# _____
Serial #: _____ Total Time _____
Mag. Type _____ Model _____
Alt. Type _____ Voltage _____
Amperage _____
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Turbocharger Intercooler _____
Oil Cooler Large Large De-congealing
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TEXTRON LYCOMING
REPLACEMENT ENGINE SPECIFICATION LISTING

ENGINE MODEL: T1O-541-E1C4
ENGINE PART #: 7052

ENGINE DATA	
VOLTAGE: 24	CYLINDER: WD
HORSEPOWER: 380	SUFFIX NO.: 59

AIRCRAFT MANUFACTURER: BEECH
AIRCRAFT MODEL: 60
AIRCRAFT TYPE: DUKE

ACCESSORIES PROVIDED WITH ENGINE

ALTERNATOR:	OIL COOLER: 100468
CARBURETOR:	OIL FILTER: Yes
CONTROLLER (DIFF):	MAGNETO: S6LN-1208, 1209
CONTROLLER (DENS):	SPARK PLUG: RHB-32E
CONTROLLER (VARB): 481008-8	SONIC NOZZLE: Yes
FUEL INJECTOR: RSA-10DB1	STARTER: MHB-4017
FUEL PUMP:	THERMO BYPASS VALVE:
HYDRAULIC PUMP DRIVE: AN	TURBOCHARGER: 407540-3
INTERCOOLER:	VACUUM PUMP DRIVE: AN
MOUNT PREP: DYNAFOCAL	WASTEGATE: Yes

REMARKS: RETARD BREAKER MAGNETOS. CONTACT SERVICE HANGAR.

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	Core Deposit		\$30,100
Factory Reman	TIO-541E1C4	\$53,216	\$43,500
	Core Deposit		\$30,100

Leadtime 6-8 wks
Comes with exh. minus tailpipe

Because these are factory engines, they include new cylinders, pistons, rings, valves, etc. And of course, they carry the factory's warranty.

As an authorized factory distributor, we handle all warranty claims on these engines.

All prices are FOB the factory (Williamsport PA for Lycoming, Mobile AL for Continental), and are subject to change without notice.

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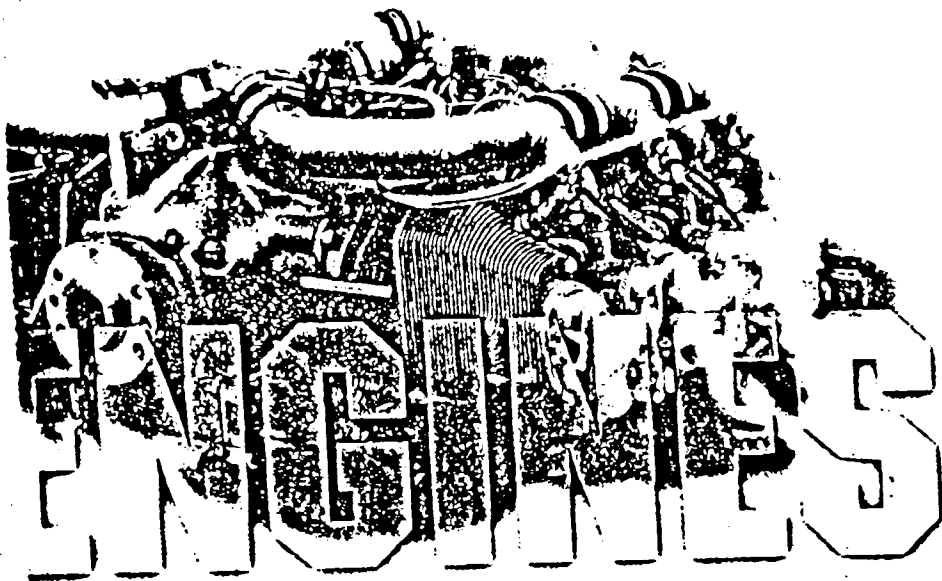
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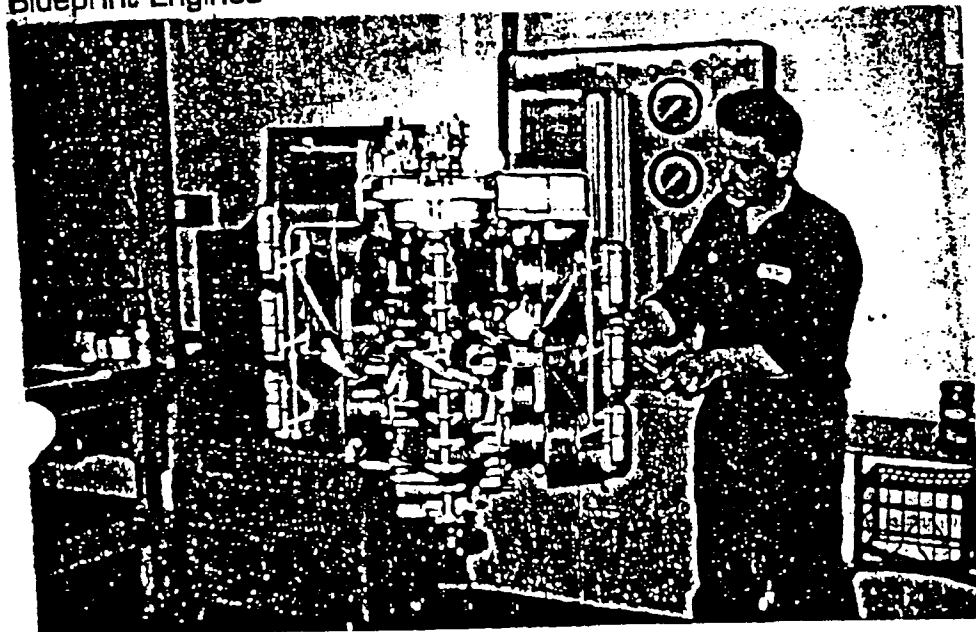


BLUEPRINT ENGINES, I
10150 VIA LITA AVE UNIT 10
CHICAGO, ILLINOIS 60641
TEL: 604-850-2200



USA Selects America's Best Overhaul Shops

Blueprint Engines



This tiny FAA Repair Station, once located on Midway Airport but now situated in a small off-airport building in Chicago Ridge, Illinois, was founded in the seventies by ex-USAF mechanic Ed Rachanski. (Funny-car aficionados may remember Rachanski as driver of the Lincoln-Mercury team's *Marauder* Comet back in the sixties). Today, the senior Rachanski spends most of his time as an independent accident investigator; the shop is run by sons Mike and Eddis, who somehow manage to pump out close to 100 engines a year, year after year.

The Rachanskis have successfully resisted the temptation to grow bigger over the years (although it's clear that they *could have grown much bigger*), simply because they want to retain control over quality. "When you've got 30 employees, you don't have the kind of quality control we have," Eddie says. "You lose something when you get that big. That's not for us."

What do you get with a Blueprint Overhaul? For one thing, factory parts, like Penn Yan, these guys don't much believe in "will-fit" (PMA) parts. You also get something that's very rare in the industry these days: good valve-guide to valve-seat concentricity. (Mike Rachanski has special tooling that enables him to sink a seat-hole dead-center on the guide axis). The Rachanskis are big believers in proper honing (of everything—valve-guide ID's, guide and seat cutouts, you name it) and of using an oven to heat cylinders prior to guide/seat installation. (Penn Yan and others use the blow-torch technique, which is fast but risky in terms of head-warping). Attention to details like this results in the Rachanskis being able to say, for example, that they "haven't had a guide or seat come loose, ever" on one of their engines. Blueprint engines also tend to break in immediately and give good compression for years.

As small, detail-oriented shops go, this is definitely one of the best.

On the plus side: These guys are experts at honing and machining. Sticklers for quality throughout (won't reuse camshafts; often ask the customer to buy factory-new cylinders). One of few shops to engage in "power balancing" (co-ing the combustion chambers and arranging cylinders for best dynamic balance in the firing order). Willing to take on turbocharged, geared, and helicopter engines, as well as run-of-the-mill mills. One of the original FAA Repair Stations to use a dynamometer for run-in.

On the minus side: No flow bench (no porting). Limited shop capacity (they barely met our volume cutoff for this article). Coordinate your schedule far enough in advance, however, and you should have no trouble getting a slot on the Blueprint calendar. FMI: Blueprint Engines, Inc., 10150 Virginia Ave., Unit B, Chicago Ridge, IL 60415. (708) 499-0702.



Ed Rachanski, Sr. with sons Ed and Mike.

the Blueprint Difference

by Kas Thomas

One of the nice things about the overhaul business—as opposed to the engine manufacturing business, say, or the PMA parts business—is that almost all the really successful shops are family-owned and run. Which is good, because it means you can be sure there's somebody at the top who cares about things other than quarterly earnings and shareholder reports and all the other bean-counterly bullpitt that makes Textron (for example) what it is today. It means there's a very special type of *accountability* that doesn't exist in a big corporation. Someone's *personal* reputation—someone's family coat of arms—is at stake. Which (let's face it) *changes everything*.

Family-owned businesses also tend to reflect the peculiar idiosyncracies—the unique biases—of their owners. This can be a blessing or a curse. But the great thing about living in a free country is, if you don't like the way Ray Kroc does burgers, Dave Thomas is right down the street.

Not everyone agrees with how Blueprint Engines does engines. Some people would rather reuse a cam than throw it in the trash. (Blueprint's policy is 100% new cams and lifters. Period.) Some people would sooner chrome-plate than punch a barrel oversize (Blueprint prefers oversizing), but hey: you wanna spray-paint your engine and call it "rebuilt," there are overhaulers who will accommodate you. Blueprint has its *own* way of doing things. The Rachanski way.

The Rachanski way is largely the doing of Ed Rachanski, Sr., ex-Air-Force mechanic and founder of the Blueprint. Although he technically no longer runs the shop, Ed Sr.'s influence is felt throughout the small, family-run operation. After leaving the Air Force (where he maintained C-119s and kept Wright R-3350s from spontaneously disassembling), Rachanski became intensely involved in drag-racing, eventually landing a spot on the Lincoln-Mercury team (which included, at that time, "Dyna-

Don" Nicholson and George DeLorean, among others). When he wasn't touring the country in his *Marauder* Comet, Rachanski rebuilt engines at home in an increasingly busy shop. Aircraft-owning friends came to him with engines that needed rebuilding; Rachanski obliged. Ultimately, sensing that he could turn aircraft engines into bread and butter, Rachanski moved to Midway Airport and obtained FAA's blessing as a Certified Repair Station. Blueprint Engines was born.

Today, after 20 successful years in the aircraft-engine biz, Ed Rachanski, Sr. has semi-retired to become an independent aircraft accident investigator (he was the lead engine expert on the Long Beach, CA, Malibu crash)—something that grew naturally out of his shop experience. "I believe Blueprint was the first Certified Repair Station to have a working dynamometer in the shop," Rachanski recalls. "Every once in a while, there'd be an accident in the

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Chicago area, and FAA or NTSB would ask if they could bring us the crashed plane's engine and run it in our dyno. That's how I got started in the accident investigation business."

Rachanski's sons, Mike and Eddie, have taken over day-to-day operation of the shop. By virtue of their early exposure to Dad's race-car experiences (which included working on Indy engines), and the more recent forensic examinations of crash-site engines, plus the usual fallout from 20 years in the aircraft engine overhaul biz, the Rachanskis have acquired a unique perspective on engines. They've seen, heard, tried, and dissected every trick part and overhaul technique known to NASCAR; they've picked apart turbocharged Continentals that have, quite literally, crashed and burned. They know what makes a race-car engine blow up; they know what makes a Lycoming piston melt. As a result, they're not about to do anything stupid to your engine—or let you do it, either.

Ground Rules

There are certain ground rules at Blueprint. For example, camshafts

and lifters don't get reused; they go in the trash. "We're not trying to say that the people who do regrinding do bad work or anything like that," Ed Rachanski, Jr. points out. "It's a matter of philosophy. We just feel, for our customers, the best thing is a new cam and new lifters." (That doesn't necessarily mean *factory new*—many of Blueprint's cams come from Air Support International. "We're very satisfied with Air Support's cams," Rachanski notes.)

Another ground rule: Ed Rachanski, Jr. decides whether your cylinders are reusable or not, and if they're not, you'll be asked to buy new cylinders. "Basically, our policy is, we'll take a first-run Lycoming cylinder ten thousandths' oversize, or we'll take a first-run Continental cylinder fifteen over," Rachanski says. "That's if everything checks out okay as far as cracking of the head goes. After the second run, Nu-Chrome becomes an option. But it all depends what the cylinders look like. If they're good, we can reuse them, but if they're cracked, we replace them with new and ask the customer to bear the added cost. Some engines, particularly the Duke engine and your Navajo engines, the big TIO-

540 Lycomings, we just tell customers to buy new cylinders and be done with it." Blueprint uses no Engine Components cylinders.

Crankshafts that can be cleaned up with light polishing get reworked in-house; those that need an undersize grind get sent out to Aircraft Specialties Services in Tulsa. Crankcases get trued up by Ajax in San Antonio. "We've had very good luck with our cases," Rachanski points out. "What convinced me on Ajax was the helicopter engine cases we started send-

ing them ten years ago. That HIO-360 engine is really hard on cases. They fret and wear—they're just plain tired at the end of a TBO run. But Ajax does a terrific job with them. They align-bore and recertify the cases, and when they come back to us they're fully Anodized and deburred. We've never had one fail."

For run-of-the-mill accessories—magnetos, starters, and such—Blueprint uses Terry Norris's Aircraft Systems, in Rockford, Illinois (one of the country's most highly qualified—and most highly regarded—independent accessory rebuilders). For turbochargers, controllers, and wastegates, Blueprint goes to Mike Rogers at Kel-Pak. TCM fuel systems get sent out to Mike's Fuel Metering in Tulsa, while Bendix systems get sent back to Precision. Net result: "We get very few comebacks for accessory problems," Rachanski remarks. (Accessory-related problems make up the bulk of warranty complaints at some shops.)

No Break-In

Engine break-in is another area where Blueprint deviates significantly from centerline. The Rachanskis simply don't believe in break-in. "If you build a cylinder up, and the cylinder is perfectly round, and you use a cam-ground piston, with the correct tolerances, and put a film of oil between the parts, *what is there to break in?*" Ed Rachanski, Jr. asks. "Stop and think. If there's oil between the parts, why would you need to 'break' anything?"

"What we do," Rachanski says, "is put a very carefully controlled hone finish on our barrels. Then we go back over the barrel with a Flex-Hone"—also known as a porcupine or ball hone—"to knock off all the torn and folded metal, and 'plateau' the peaks. This gives the best possible surface for the rings. They seat immediately, the first time you run the engine. When the engine comes out of our test cell, it's completely broken in."

Since no further break-in is needed, Blueprint ships all customer engines with either SAE 50 Aeroshell Oil W (ashless dispersant) in the sum-



Ed Rachanski, Jr. does most final assembly work.

Although Blueprint has done GTSIO-520 Continental, most engines are ungeared Lycoming sixes.

mer or Aeroshell 15W-50 in the winter. No mineral oil is ever used.

"The key, really, is knowing how to use a Flex-Hone," Ed Rachanski, Sr. confides. "Those sharp, cut metal edges that you get after putting the crosshatching in, those microscopic folds in the metal actually glow red at operating temperature. They glow red-hot and coke the oil. When you get rid of that, you get rid of glazing and oil breakdown, you keep metal from contaminating the oil system—you get rid of 'break-in' problems."

Secret Ingredient

Blueprint pioneered the use of Lenckite oil additive in aircraft engines (see *TBO Advisor*, March-April 1994, p.7) and considers it a key ingredient in every overhaul: Not only does Blueprint send every customer engine out the door with a supply of Lenckite, but the additive finds extensive use during the actual process of engine buildup. Certain parts will be coated with Lenckite and then held at 150° to 200° in an oven for an hour or so, prior to final assembly. The Lenckite pre-treatment causes the parts to "soak up" a certain amount of the oily substance and stay wet during future dry starts. In this way, a good deal of possible scuffing wear is avoided in the engine's first hours of operation (and for some time thereafter, according to Ed Rachanski).

The Rachanskis credit Lenckite with reducing warranty claims to near-zero (as far as cylinder scoring and piston scuffing go) and helping customers get longer life out of cylinders, valves, and guides. "We feel pretty strongly about it," Ed Rachanski, Jr. admits. "It's helped our customers a lot." (One of Blueprint's customers—nearby Executive Helicopter—got 7,700 hours out of a set of TIO-360 cylinders built up by Blueprint. See *TBO Advisor*, March-April 1994.)

No Porting

Given the Rachanskis' race-car background, you might think they'd be the first to put porting and polishing to work for their aircraft-engine customers. But you'd be wrong. A flow-

Mike Rachanski measures the combustion chamber volume of a Continental TSIO-360 cylinder. Cylinders are "power balanced" by arranging high- and low-volume cylinders in a special order. Blueprint is one of very few shops to employ this technique.

bench is one piece of gear you won't find at Blueprint. Ed Rachanski, Sr. (one of few aircraft-engine overhaulers who can claim to be a member of the Society of Automotive Engineers) explains Blueprint's position this way: "Porting is something whose benefits really begin to come into play after 5,500 rpm. On lower-rpm engines, you really don't get much benefit. Just look at an engine like the Continental O-470. I mean, you've got intake pipes that aren't tuned, you've got a muffler in the exhaust—what's the point of flow-matching the cylinders? You 'unmatch' them the minute you hook up those pipes. If you were turning 6,000 rpm, then it would be another story. Maybe."

On the other hand, the Rachanskis do believe in "cc-ing" and power balancing. Mike Rachanski demonstrated his technique for "cc-ing" (measuring the combustion chamber volume of) a Continental TSIO-360 cylinder. First, valves are installed and the spark plug holes capped off to prevent fluid leakage. Next, the jug is inverted on a special tabletop and bolted down. A special swivel-arm (with a vertical "dipstick") is lowered into the open end of the cylinder barrel; the exact depth to which the dipstick portion is lowered is determined by a metal pin on the outside of the cylinder barrel, which hits the limit of its movement when it contacts the cylinder hold-down flange. At this point, the cylinder is filled with a known amount of fluid (naphtha); the cylinder is checked for leaks, which would indicate poor valve sealing. Assuming there are no leaks, Mike continues to fill the cylinder barrel with fluid, until



the "dipstick" reads at the proper level (an arbitrary mark). The final few milliliters of naphtha are added with a calibrated buret. When the dipstick mark is reached, all the "fluid added" numbers are added up to determine the actual cylinder volume. Then the next cylinder is brought to the table and measured in an identical fashion.

In the end, you know what the actual cylinder volume is for each cylinder in a set—and you know how far apart the "best" and "worst" cylinders are. Typically it's 20 or 30 ml. (The differences are mostly due to differing valve heights and irregularities in cylinder head castings, particularly around the spark plug holes.) Unfortunately, FAA doesn't allow any machining inside combustion chambers to "even out" the cylinder volumes among cylinders. But clearly, if one cylinder has more clearance volume than another, its compression ratio (and power output) will be different as well.

Blueprint attacks the problem by arranging the cylinders in a particular order on the crankcase, using what a mathematician might call a "least differences" algorithm. "We power

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ance an engine differently than just about anyone else in the business," Ed Rachanski explains. "What we try to do is minimize the power differential between cylinders in the firing order. What you don't want is a high-output cylinder firing directly opposite a low one. We try to achieve the least horsepower difference going from one cylinder to the next, in the firing order. This smooths out an engine like you wouldn't believe."

Also tending to make Blueprint-built engines smooth is the attention to mass balance given such items as con rods and counterweights. "We 'gram' your rods and counterweights," Ed says. "The counterweights, for example, have to be within half a gram. We consider balance to be very important."

Good Geometry

Something else the Rachanskis are sticklers about is "truing up" seat and guide geometries. Most shops pop old seats and guides out, hand-ream the holes, put new inserts in, and grind seats with a motorized grinder than pilots off the guide boss—a lousy way to maintain concentricity between guide and seat. At Blueprint, special tooling is used to hold the cylinder while the seat hole is cut directly on-center with the guide (and 100% square to the guide in the transverse plane), so that the valve-seat contact area is uniform and heat dissipation is optimal.

Not only that, but seats and guides are installed in a cylinder that has been oven-heated, rather than torched. "You go into most shops," Ed Rachanski says, "and they have the torches going, and the cylinders sitting there shooting blue flames out the ports. That's not the way the factory does it. We do it like the factory does. It takes a little longer, maybe, but we don't warp anything, and let me tell you, when one of our seats goes in, it doesn't come back out. You never hear of one of our engines dropping a valve seat, or having a guide pull loose."

One-on-One Service

Because Blueprint is small (60 to 80 engines a year) and family-run, the principals—Mike, Eddie, and Ed Sr.—have time to deal with customers' concerns one-on-one. "I generally will invite the customer down, if he's in this area, to come and look at his engine after it's all apart," Eddie

"What we try to do is minimize the power differential between cylinders in the firing order."

notes. "We save all the old parts. If there's crankcase fretting, we show the customer what it looks like and explain it to him. Sometimes I'll spend two or three hours—whatever it takes."

Magnafluxing and careful inspection of steel parts (especially the crankshaft) is taken very seriously by the Rachanskis. They've seen the results of prop strikes—both pre- and post-accident—and treat any prop strike in a counterweighted engine with grim seriousness. "What we'll often do, if the customer has the money," Eddie says, "is radiograph the crankshaft and counterweights." A full x-ray series costs about \$450, according to Rachanski, but is worth it since Magnafluxing only detects surface flaws. (Radiographing is not mandatory; it's up to the customer.)

In general, Blueprint tries to do what the customer wants—as long as it's consistent with safety. "We had a Mooney customer once," Eddie recalls, "who insisted that we build him a special engine. It had to have the -D1A helicopter pistons, a counterweighted crank, a different prop, the whole nine yards. We told him there was no way to get it STC'd. He didn't care. He went out and registered his Mooney in the Experimental category. And for a while there, he had just about the fastest Mooney in existence. It later turned out he couldn't sell the plane to anyone—no one wanted an Experimental Mooney—so he had us take it all apart and convert the engine back."

Special Expertise

Blueprint is capable of overhauling almost any current-production Lycoming or Continental engine.

While we were there for this story, we saw a variety of engines apart, including O-300, TSIO-360, IO-520, and GTSIO-520 Continentals, plus a Lycoming O-320-H2AD. (They still do the occasional helicopter engine, too.) Still, Ed Rachanski, Jr. sees his shop as primarily a six-cylinder Lycoming shop. The bulk of Blueprint's 60-to-80-engine-a-year business is with operators of Navajos, Dukes, Aztecs, Saratogas, and Skylane RGs. "We actually stock some exchange engines for the Navajo Part 135 operators," Eddie says. "Mostly, we're a custom overhaul shop. We take the customer's core and overhaul it. But we do stock some exchange engines."

Most engines arrive at Blueprint via motor freight, but customers who prefer to fly in can get R&I services (engine removal and installation) at Priester Aviation at nearby Palwaukee Municipal (PWK).

Small Is Beautiful

Blueprint is such an impressive shop—competent, thorough, efficient, experienced, reasonably priced (prices are on a par with, say, Firewall Forward; e.g., \$35,300 for a TIO-541-E1C4, with new cylinders), and dyno-equipped to boot—that you wonder why they haven't grown to become a 200- or 300-engine-a-year behemoth. But as it turns out, the Rachanskis tried "big," and "big" wasn't for them. "Back when we were at Midway Airport," Ed Sr. recalls, "we had eight or nine guys in the shop. We were starting to get big. And we just couldn't keep control over quality. So I always told the boys, don't ever try to do 200 engines a year. You lose too much."

Thus, Blueprint remains small by choice. They're big on quality and service, however, and we certainly hope they can grow to accommodate the 100 or more engines a year that they will almost certainly be forced to do once word of their quality and attention to detail begins to spread. As small, family owned shops go, this one rates five stars.

Blueprint Engines, 10150 Virginia Ave., Unit B, Chicago Ridge, IL 60415. Phone (708) 499-0702. □

Trade-A-Plane blog

The Best of the Aircraft Industry, News, Products &
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Power by Blueprint, Inc. Offers Performance-built Aircraft Engine Overhauls



Power by Blueprint, Inc. offers performance-built aircraft engine overhauls

Personalized overhauls are backed by the very best industry warranty—and the warranty is transferrable

BEDFORD PARK, ILL., May 10, 2016 – With over 40 years of experience in serving the industry with the finest personalized products and service, the Blueprint name has been recognized for safe, dependable and performance-built aircraft engine overhauls. Ed Rachanski, Jr. and his brother Mike have established to continue offering the finest personalized engine overhauls in the industry.

The Rachanski/Blueprint background includes several noted industry firsts, such as developing a study on stresses incurred to the engine during a prop strike incident. This study provided the necessary evidence

to the insurance industry that an engine teardown was necessary after a prop strike. The Blueprint report helped aircraft owners be reimbursed for engine teardown inspection costs from insurance companies which improved safety and lowered liability for both operators and insurance companies.

Blueprint's commitment to the very best workmanship and customer support was recognized after aircraft owner survey. Blueprint was named one of the nation's finest engine overhaul facilities by *Aviation Consumer* and *US Aviator* magazines.

Shell Oil Co. selected Blueprint to be featured in its national ad introducing Shell's first multi-viscosity aviation oil. Blueprint also conducted extensive field testing on their engine overhauls through the Great Lakes Manufacturing and Engineering Division of the FAA to receive FAA Approval for the AvBlend oil product.

A state-of-the-art machine shop equipped with the latest dynamometer technology is used to provide the very best overhaul for Blueprint's valued customers.

Blueprint overhauls, which are built to factory-new limit specifications using genuine factory parts, also meet and exceed the manufacturer's list of required replacement parts. New cylinders and camshafts are included in Blueprint's overhauls for very specific reasons.

The initial startup of a newly overhauled engine is very critical. AvBlend keeps friction surfaces cool during the break-in period. Too much heat while the metal is forming itself into its job can easily cause brittleness, loss of flexibility and a tendency to break under sudden and severe strains.

AvBlend allows metal to temper itself under working conditions and assume the right degree of suppleness and hardness for the job it is expected to do during its entire service life. This is known as work tempering (energizing) and can only be accomplished under conditions where excess frictional heat is eliminated. AvBlend allows proper break-in to occur while reducing conditions for cylinder wall glazing during the initial hours of a newly-overhauled engine's life.

Only Blueprint uses the AvBlend Fusion process, treating all metal parts before the engine is assembled. This important process helps set the operational path for allowing your engine to achieve optimum performance throughout its entire service life.

Other beneficial steps include multi-angle valve/seat machining, power balancing the cylinder combustion chambers and special finish cylinder wall honing to eliminate peaks which allow rings to seat without

damaging their edges. (Without this process, broken-off metal edges on the cylinder wall crosshatch go through your new engine bearings, etc.)

The crosshatch pattern aids in better cylinder wall lubrication control and retention for improved oil consumption and combustion "peak pressure" efficiency. Proper valve/seat and cylinder wall/piston and ring sealing are an absolute must for safe takeoff, climb and cruise performance.

Blueprint feels communication with the customer on proper engine operation is key in achieving and maintaining optimum performance for the engine's service life. Blueprint supports its personalized overhauls by the very best industry warranty, which is three years or TBO, whichever occurs first. And the warranty is transferrable to another owner.

For more information, contact Ed Rachanski, Jr. direct at 708-790-0108 or email him at Ed.Rachanski@gmail.com.