Light Plane Maintenance®

Practical maintenance advice for owners and pilots

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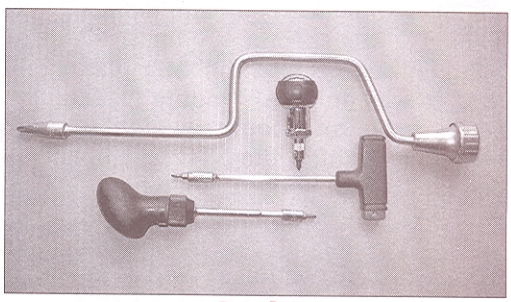

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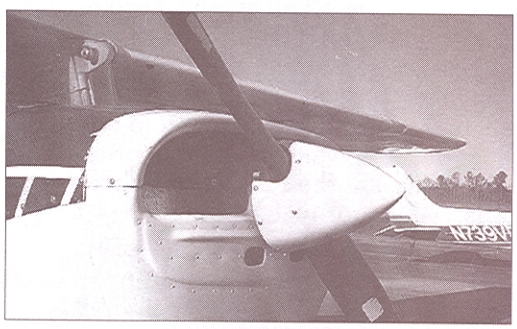

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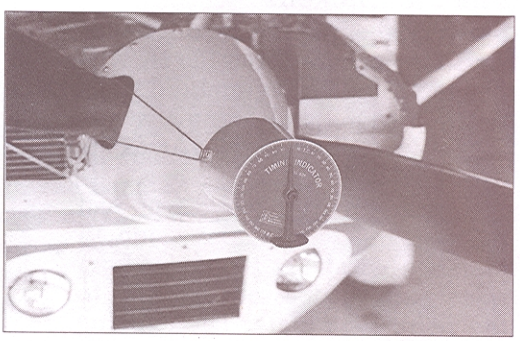

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Inside LPM

Continental O-200

The venerable O-200 was selected by the Voyager team for the around the world flight.

by Mike Berry

The Teledyne Continental O-200 engine was certified by the FAA under CAR part B with a type certificate number of E 252. This certificate is shared with the C-90 engine and variants as well as the O-200, O-200A and O-200B models. It is currently out of production, with the IO-240 taking its place as the smallest of the Continental engines.

The O-200 has roots back to the 1940s and even earlier. It has a displacement of 201 cubic inches, a dry basic weight of 190 lbs., 100 hp at 2750 RPM, and a minimum fuel requirement of 80/87. It has a bore of 4.06 inches and a stroke of 3.87 inches.

Some O-200 models were configured for a variable pitch propeller (O-200C), some with fuel injection, and other models designed for pusher type propeller installations (O-200B). The most common engine is the basic O-200A model with the original Marvel Schebler carburetor (now owned by Precision), fixed-pitch prop, Slick or Bendix mags, provision for a vacuum pump, fuel pump, and oil cooler. It's equipped with a starter and generator or alternator and shielded ignition system.

This engine and other similar models have been very reliable provided that they are (as quoted from the official Type Certificate statement) "installed, operated, and maintained as prescribed by the approved manufacturer's and other approved instructions."

This is an important statement in that any maintenance or operation not consistent with "approved procedures" may degrade the performance and reliability of this and any aviation product.

Improvements have been made to this engine over the years and many more years of use can be expected. Parts availability, factory technical support as well as aftermarket support are available. As with any product that was originally introduced over 50 years ago this engine has had few problems that can be attributed to poor design.

The engine crankcase is machined for rubber engine mount "bushings" as opposed to a Dynafocal mount system found on more modern engines. The forward crankcase incorporates a "boss" for the installation of a crankcase breather.

The air intake system consists of an external manifold with individual supply tubes to each cylinder, and a carburetor attached below the manifold in a standard aviation "updraft" arrangement. Below the carburetor is an air intake housing, carb heat box, and an attachment for an air filter.

To the rear of the carburetor is the kidney shaped oil sump and further aft is the accessory housing incorporating the oil pump and oil screen as well as machined pads for magnetos, tachometer drive, generator, and starter drive.

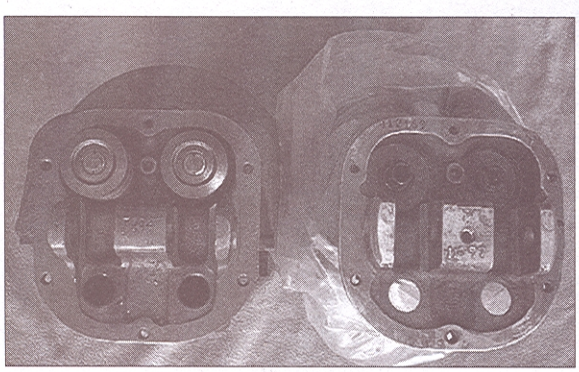
The introduction of the starter and generator was a giant leap forward as earlier engines of the 50, and 65 hp range had no provision for a starter or generator. The design of the earlier 4-cylinder engines together with weight considerations for aircraft with limited weight carrying ability restricted the use of an electrical system.

The O-200 has hydraulic lifters, and the push rod tubes (2 per cylinder) are swedged to the upper cylinder but are connected to the crankcase by tubes secured with special "rings." Pushrod tubes occasionally leak oil from this swedged connection although it may seem the valve cover gasket is leaking. Correcting a leaking push rod tube requires that the tube be re-secured (special tool).

REAL gasket company Corvallis OR, Ph 541-754-3622 makes a kit that incorporates a replaceable (STC approved) seal design similar to the later model TCM engines. New style TCM cylinders also have been improved with similar tube seal rather than the swedged on original metal to metal tube connection. REAL also makes silicone (reusable) valve cover gaskets to replace the original cork style gasket.

While this engine is very simple it does have some "special" characteristics that require discussion. The design of the float-type carburetor and intake system seems to promote carburetor icing more so in this engine than in similar type engines by other manufacturers. For this reason the carburetor heat system must be maintained in near perfect condition and used faithfully prior to reduction in engine power or any time carb ice is suspected.

The exhaust system, heat muff, and mufflers must also be well maintained. Worn carb heat butterfly bushings or bearings must be promptly replaced; operating cable and linkage must move the carb heat butterfly full travel with no "hitches." Cracked sheet metal baffling, exhaust leaks, and missing muffler baffles must be repaired or replaced.



The Continental p/n 653816A3 cylinder kit, right, has a cylinder with a heavier head casting, a rocker shaft retaining screw, and removable pushrod tubes. The assembly comes with a piston, pin, rings, rocker shaft, pushrod tube kit, and gaskets. All you reuse is the rocker arms, the rocker box cover and pushrods. Overhauling old cylinders would cost nearly as much.

Contrary to popular belief, muffler baffles are not for the purpose of noise reduction but to provide some back pressure as well as retain and exchange heat when the engine is operating at low power. Mufflers that are not completely intact including baffles are not airworthy. All clamps, braces, and brackets should be checked for cracks or damage and repaired or replaced if required.

With only four cylinders and the old mount system, more vibration occurs causing cracks and damage to airframe and engine components. Engine vibration together with frequent use of throttle, carburetor heat, and mixture controls require more frequent operational checks.

The use of auto fuel can contribute to increased formation of ice in the carburetor under certain atmospheric conditions. The discussion of the carburetor would not be complete without including the latest AD (98-01-06) and service information (Precision bulletins MSA 2 and MSA 9) regarding the Precision brand float type carburetor venturi.

It is important to verify that the installed carburetor is the correct one for the engine. Many models of carburetors will fit on the intake manifold but only a few specific part number carburetors are approved for the O-200A engine. The part number (not the model) identifies the exact jets, settings and details necessary to operate the engine correctly.

An incorrect part number carburetor cannot be exchanged for the correct (different) one so a *new* (expensive) carburetor must be purchased. Early carburetors were equipped with composite floats that were attacked by 100-octane fuel and auto fuel and actually absorbed fuel causing the float to partially sink making for a rich mixture.

Metal and latest factory supplied composite floats are safe for use with auto and 100-octane fuels and should always be used when repairing or overhauling a carburetor.

The original nozzle when installed in conjunction with the single piece venturi sometimes caused engine roughness and rich conditions in the O-200. This required replacing the original nozzle with a nozzle "kit" specially designed for the O-200. This replacement (kit 666-942) is covered by precision bulletin MSA-7 and was replaced for no cost to those who produce a receipt for the purchase of the precision brand venturi. Call Precision at 800-838-8181.

The O-200 engine was originally designed for 80/87-aviation fuel. As this fuel disappeared problems developed with the use of the 100-octane fuel with much higher lead content. Auto fuel was extensively tested by the EAA and approved under STC obtained by the EAA as well as Petersen Aviation.

While it may seem that auto fuel was just the ticket to replace the 80/87, this was not quite the case. Operation with unleaded auto fuel or 100-octane avgas eventually leads to valve problems unless cylinders have the latest style hardened valves, seats and guides.

As a separate issue stuck valves plagued many engines originally designed for 80/87 and were operated on 100-octane fuel. This stuck valve problem has been corrected with the use of improved valve assembly materials and tolerances as well as improved materials used in valve manufacture, and correct valve seat angles.

A newly available strengthened cylinder incorporating the latest valve/seat/guide modifications allows the engine timing to be advanced to the original 28 degrees BTC according to TCM bulletin MSB 94-8A and AD 96-12-06.

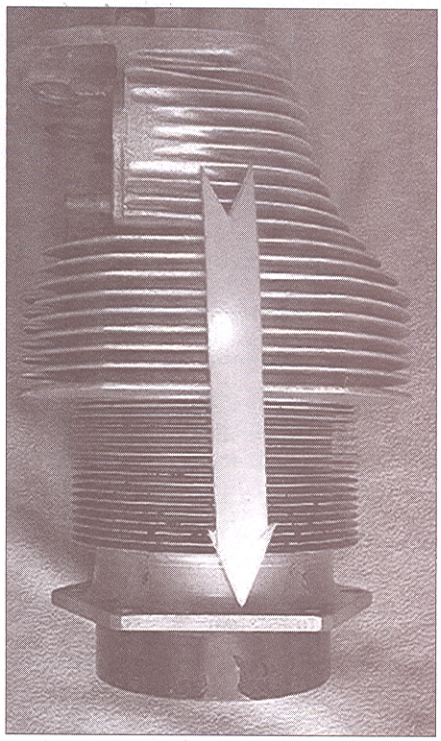
An original specification for the O-200 engine called for timing to be set at 28 BTDC but was changed to 24 BTDC when cylinder cracking became an issue with the original style cylinders. The timing advance to 28 BTDC can only be done when all four cylinders are replaced with the qualifying "new" cylinder assemblies (including Superior).

Eyeballing the timing is a bad idea; the timing marks on the crankshaft flange can easily be misinterpreted.

When working on cylinders (or engines) always use the most current approved part as there are old "new surplus" parts available at a reduced price but these are no bargain if you experience a stuck valve or require premature engine maintenance.

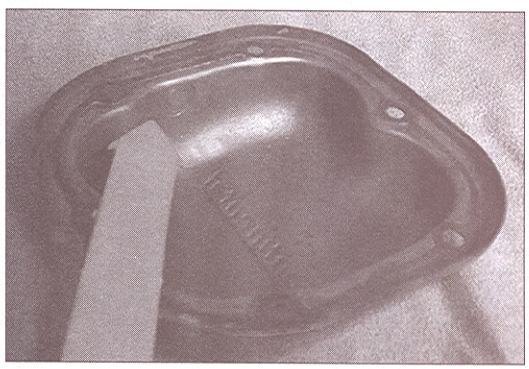
AD (94-05-05 rev1) addresses rocker shaft boss inspection for cracks and dimensional inspection is required for all cylinders every time a cylinder is removed. "Parts having discontinuities (cracks) shall be rejected." However, certain FAA approved shops are allowed to repair (weld) cracks in cylinders.

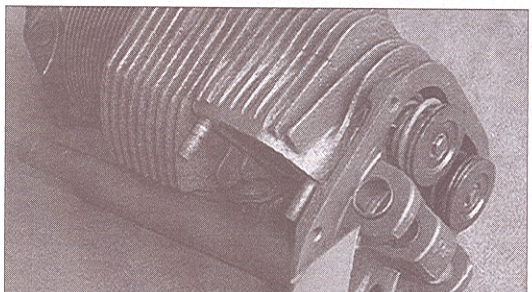
Rocker bosses that are not within



If you have Continental cylinders, you need to look for p/n 653816A3 (arrow). These improved cylinders are OK for advancing the timing back to 28 deg from the previously AD mandated reduction to 24 degrees. Using Superior cylinders will also permit this timing advance.

Rocker shaft damage to this valve cover is due to a lack of shaft stability. Continental fixed the problem when they introduced the new p/n 653816A3 cylinder assembly. The fix was the installation of a set screw in the boss between the rockers which locks the shaft in place.





Repair bushing is the result of the rocker shaft being able to move about with minimal lubrication. This wears out the bosses, requiring the bushing per AD 94-05-05 R1. The new cylinders solve this problem.

limits can be repaired according to the TCM overhaul manual by reaming and the addition of bushings. Cracked or broken rocker bosses are a serious problem and effectively "shut off" the cylinder. While not proven, stuck or sticking valves can contribute to rocker boss cracks and failure; another reason to use the current valves, valve guides and adhere to the strict tolerances of valve stem-to-guide clearances.

Starters on TCM engines require an adapter and clutch unit to engage the starter rotational movement to the engine. The Cessna 150 with O-200 engine had two types of starter drive: the early style pull-type and the later style key-start model.

The pull model should have sufficient cable tension to the hold the shift lever in the fully released position or excessive wear will result. Carefully follow the overhaul manual adjustment procedure.

Key-type starters are energized by the ignition key through a solenoid. The rotation of the starter engages an overrunning clutch in the starter adapter, which turns the engine. The key to both systems is the proper operation of the clutch.

The early pull starter adapter is generally more reliable than the later key start model as long as the adjustment is checked often and the complete adjustment procedure is followed. Single grade AD oil that is changed often as opposed to the multi-viscosity oils is the best bet for the starter systems of this engine.

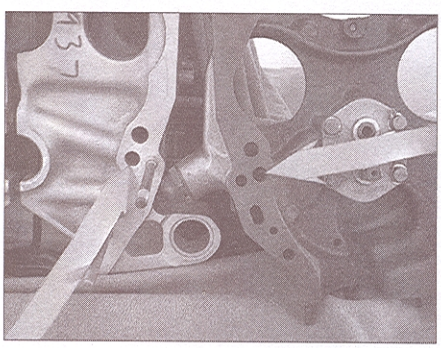
Checking the oil and oil screen or filter for metal contamination at each oil change is important as metal flakes can either identify a problem with the starter adapter or other engine problems. Metal contaminated oil can lead to premature failure of a starter clutch.

Never use oil additives unless it is certain to not harm the starter clutch. Do not operate the starter motor for more than a few seconds if the prop does not turn as damage to the adapter, clutch or engine may occur. Niagara Air Parts (800-565-4268, www.niagaraairparts.com) offers starter adapter repairs, repair kits, overhauls and can supply improved (STC approved) starters and adapters.

B&C Specialty products 316-283-800, www.bandcspeciality.com, makes a lightweight replacement starter and other accessories for the O-200 engine. Sky Tec also offers a new starter for the O-200, see www.skytecair.com.

The oil system consists of a gear type oil pump contained in the accessory housing and is driven by the cam gear. A pressure oil screen is incorporated into the accessory housing as standard equipment. Oil filters were originally available from the airframe manufacturer (i.e. Cessna) as optional equipment on the Cessna 150. Currently, oil filters using aftermarket adapters are available as an approved modification.

The right arrow points to where the oil is routed from the oil pump through passages in the case. The left arrow points to where the oil flows to the other case half, and is a potential internal oil leak. No gaskets are used. The result is constant low oil pressure with poor mating.



Inspection Basics

Be systematic and write things down. Start by researching the history in the engine logbook. When was it last overhauled, who did it, what parts were replaced, are there specific details as to part numbers, yellow (maintenance release) tags, work orders etc.?

Recommended overhaul for the O-200 is 1800 hours or 12 years. Many times engines are overhauled for economic reasons (cracked crankcase or low oil pressure etc.) not because the engine was due for overhaul.

Were all the parts required to be replaced actually replaced according to the TCM bulletin M87-11? The position of the FAA and "overhauls" is that unless all the required inspections, parts replacements, and repair processes and testing specified in the manufacturer's overhaul manual followed exactly then the overhaul is not valid and cannot be considered as such.

Was the crankcase overhauled? Were the cylinders "repaired" or actually overhauled or replaced with new cylinders? When were the accessories overhauled; is the carburetor modified to the latest configuration? When were the magnetos last overhauled or replaced? This information is important as even though an engine may be low time, cheap overhauls do not make TBO.

What were the compression readings at the last inspection and how do they compare to the previous readings? Does the serial number and model number on the data plate match with what the logbook states and is the engine approved for installation in this aircraft?

The person doing the inspection needs to have current knowledge and data available to check for AD note compliance, that the proper parts and accessories are installed, and that the engine meets its type design specifications or is in an "approved" modified condition. Modifications that are STC approved must have the proper documentation, including copies of 337 forms, instructions for continued airworthiness and possibly flight manual supplements.

Unapproved modifications render an engine unairworthy and must be returned to the original condition to meet airworthy status. After completing preliminary research, operate the engine to check oil pressure, magneto "drop" checks, idle speed check, mixture check at idle cut off

(slight RPM increase), carb heat operation, alternator/generator operation, vacuum pump output etc.

A check of static RPM (with a known calibrated tachometer) also should be made and checked against the required value listed in the official FAA Type Certificate Data Sheet, available free from the FAA Web site. After the preliminary engine checks are done remove the engine cowling, take a compression check, and an oil sample.

Use the TCM recommended method to check engine compression. While engine compression readings are significant, many people place a high degree of importance on slight variations of compression figures without investigating the reason.

Actual low compression (i.e. 50 or less) can generally be confirmed by listening to the exhaust, intake or breather to determine the source of the leak; further investigation can be made using a borescope.

Checking the lower spark plugs for oil fouling or excessive carbon to confirm a cylinder in poor condition. Compression figures can vary because of a wide range of variables such as engine temperature, calibration of the compression gauges and even the person doing the check.

Oil samples are a good "tool" but oil samples when compared over a period of operating time can reveal more information. Just as with the compression readings, oil samples are not an exact science and should not be used as a stand-alone method.

Check for oil leaks and seeps and investigate each leak. While oil leaks can be minor, the reason for the leak may not be minor. Cracked crankcases, loose case half studs or through-bolts, or cracked cylinders can all lead to major repairs.

Another source for oil leaks is from the valve cover when a rocker shaft wears into the cover. The new style cylinders supplied by TCM have a fix for this problem with a set screw to hold the shaft in position.

Other areas to check for oil leaks are the forward crankshaft seal. A leak in this area is usually repairable with the replacement of the seal but check the logbook for multiple replacements of shaft seals.

This may indicate a problem with the crankshaft (pitting or scratches) or the seal cavity in the case worn or damaged. The oil breather should be checked for excessive oil residue indicating possible blowby.

Crankcase halves occasionally leak and while the problem of loose through-studs may cause this another cause can be worn, fretting or loose crankcase through-bolts. A tip that this may be problem area can be a generous amount of sealant along parting surfaces. This method of sealing is not an approved method of "repair" and leaks must be corrected.

Oil leaks from the accessory housing or installed accessories can also be an indication of a problem. Oil leaks around the vacuum pump must not be tolerated as any oil or oil vapor can be drawn into the vacuum pump destroying it in short order.

Check for exhaust leaks especially around the exhaust manifold to cylinder attachment area. Leaks in these areas can lead to cracked cylinders. When replacing exhaust gaskets always check for cracks in the exhaust port before replacing an exhaust gasket. Intake manifolds, pipes and rubber connector tubes should also be checked for leaks—fuel stains are a dead giveaway.

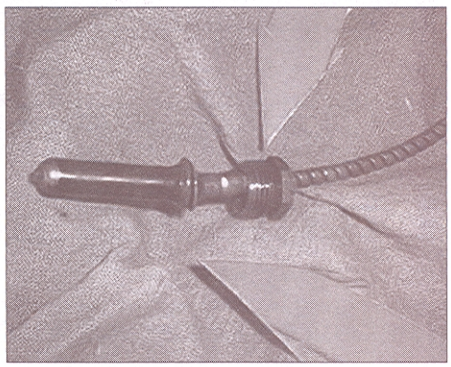
Often overlooked, a neglected air filter and air box can introduce destructive dust and dirt particles into an engine. Such wear can be rapid and require a complete engine overhaul.

There is an AD (96-09-06) on early style Bracket air filter housings that requires a 100 hour inspection of the rubber seal between the air intake housing and the filter frame. Replacement of the filter housing with an improved housing within 500 hours of the effective date of the AD will end the repetitive inspection requirement.

Paper air filters (original Cessna are paper) are subject to AD 84-26-02, which requires replacement of all paper filters at 500 hour intervals.

Problems with filters are not necessarily the filter but poor sealing around and after the air filter allowing dust to be drawn in. A final area to check on the engine is that of the ignition system especially the spark plug leads.

These are often neglected unless there is a problem. If the ignition cables are not flexible or show signs of chaffing it's time to replace individual leads or the harness.



The oil temp bulb/gauge system on older 150s is mechanical and the temp bulb, tube and gauge is one part. A hollow "nut" (upper arrow) retains the bulb in the adapter on the rear of the oil screen. This nut is fragile and easily collapsed. The entire gauge and tube/bulb must be changed as a unit. None can be purchased new.

Engine baffling should be inspected for missing, cracked or broken sheet metal and attaching hardware. Missing inter-cylinder baffling can lead to cracked cylinders or other damage from incorrect heat transfer. Check cylinders for burned paint where missing baffles are discovered.

Overall the O-200 is a stout little performer that needs to have proper maintenance to assure a long and troublefree life. On the down side as an out-of-production engine some parts can be extremely hard to find.

Be sure to not underestimate the level of care needed to assure it remains the reliable powerplant it was designed to be.

This shows the oil pressure relief valve/regulator valve removed from the accessory housing, showing the plunger, spring and cap, which is the spring and plunger guide. Also note the oil screen and oil temp bulb adapter installed in the screen housing in the accessory housing. If a Cessna oil filter adapter is installed, it takes the place of the oil screen entirely, screwing into the screen housing.