STEVE ELLS
COMMENTARY / THE WORKBENCH

The All-Important First Start

BY STEVE ELLS

IF ANY OF THE 101 SMALL DETAILS that are part of a complete engine installation are overlooked, or neglected, or if the engine is not run correctly during the first few minutes of operation, a new engine installation can quickly go from an "it's flying time" to an "it's crying time" experience.

The cooling requirements of common light airplane engines are specified in cubic feet of air per minute and by the pressure differential (measured in inches of water) between the ram air at the cylinders and the exit air after the cylinders. Engine cooling baffles and baffle seals must be in tip-top shape prior to the first engine break-in flight.

THE PRE-OIL

Engines must be pre-oiled prior to the first start. Pre-oiling is not a subject that's open for debate. I've adapted a brake bleeder pressure tank from an auto parts store for this task. I heat up 4 quarts of mineral oil to 150 degrees, pour it in, and pressurize the tank to 50 psi. Connecting the pre-oil tank to the engine at the oil pressure fitting on the engine works well. An airport local has built his out of 4-inch diameter Schedule 40 PVC irrigation tubing. He glued a cap on one end of an 18-inch-long section of tubing then screwed a plug on the other end after installing pressure and outlet valve fittings. Schedule 40 tubing is rated for 220 psi and 140 degrees F.

If no pre-oiler is available, Lycoming Servic Instruction 1241 recommends removing one spark plug from each cylinder, filling the oil tank with non-compounded (mineral) oil, and using the starter to spin the propeller. Limit continuous starter operation to 10 to 15 second then allow the starter to cool and give it two or more 10-15 second runs. At some point the oil pressure needle on the cockpit gauge will com off the peg and start to climb. When you see oil pressure in the cockpit, the filter is full of oil, and a layer of oil has been pumped into the main and rod bearings. If you want to add som extra insurance when using the starter-driven version of pre-oiling, heat the oil before you pour it in the engine oil sump — the oil will flo more completely throughout the engine.

Paragraphs VIII and IX of Continental Motors SB15-6 vary from the above procedures because it discourages the use of the starter to spin the engine for pre-oiling and because it recommends spraying oil into each cylinder prior to the first start.

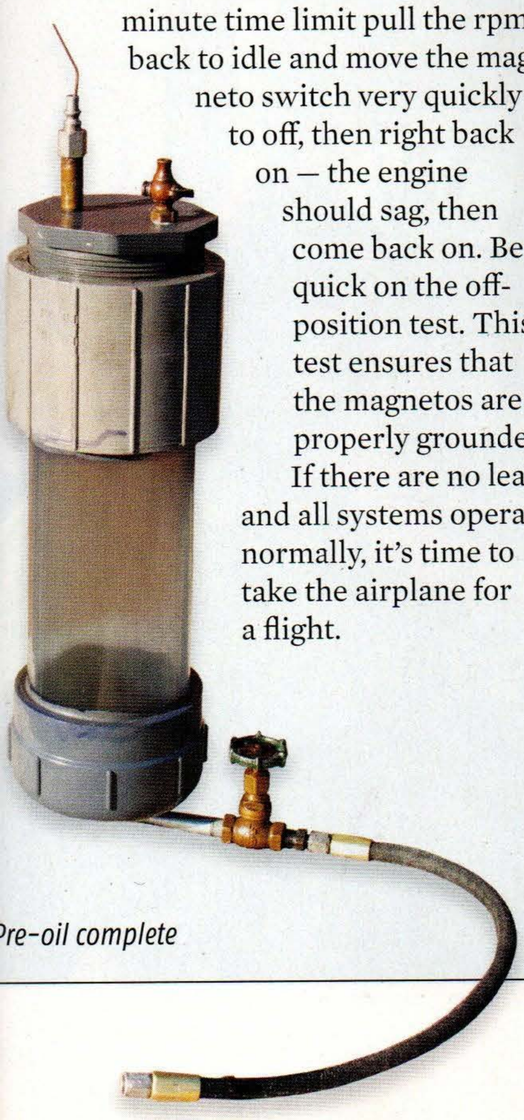
PHOTOGRAPHY COURTESY OF STEVE EL

HE FIRST START

ven though all reputable engine builders un their engines on a test stand for at east an hour before the engine is shipped, nese runs do not break in an engine. This rocess is termed a run-in, and it's conucted so that the builder can be assured nat the engine is ready to ship. It's part of standard acceptance test.

The first ground run after the pre-oil nust be done correctly. Start the engine nd run it at 1200 rpm until the oil presure starts to come off the peg — then ncrease the rpm to 1800 to relieve the nechanical pressure on the camshaft obes and lifters. Limit the first run to nree minutes. Don't touch the mixture nd don't touch the prop lever. Move the nagneto switch to the left and right posiions (momentarily hold in each position). ou should see a small rpm drop-off, but if ne rpm drops like a rock when the switch s in either the left or right position, *let the ngine die* and fix the discrepancy before he engine is restarted. Turning the mageto back to both could cause an xhaust-system damaging after-fire due to xcess fuel in the cylinders when the park plugs fire.

Near the end of the three-minute time limit pull the rpm back to idle and move the magneto switch very quickly to off, then right back on — the engine should sag, then come back on. Be quick on the off-position test. This test ensures that the magnetos are properly grounded. If there are no leaks and all systems operate normally, it's time to take the airplane for a flight.



Pre-oil complete

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DON'T RUN IT UP PRIOR TO TAKEOFF

Try to plan the first flight during the cool part of the day, and try to use the longest runway on the airport. Since cylinder cooling is almost nonexistent when the airplane is moving at less than 40 mph, ground run-ups should be avoided.

Do *not* cycle the prop — leave the prop control full forward (high rpm) for at least 10 minutes after takeoff. Cycling the propeller creates a low rpm-high combustion pressure situation that may delay or limit ring seating.

These procedures are designed to help the pilot manage the heat of combustion and control cylinder wall temperatures during the first few hours of engine operation.

If heat control procedures are not followed, it's likely that the wear between the combustion rings and the cylinder walls that is critical to begin the break-in process will be lessened. If the heat at the cylinder walls is not controlled, the surface irregularities (they're there on purpose) can become "glazed," meaning filled with oxidized oil. If this is allowed to happen the break-in process stops and the rings simply glide across the smooth, slick surface. The result is an ineffective ring-to-cylinder wall seal. Glazing is characterized by high oil consumption.

If the engine ground running is excessive, the airplane is not flown in a manner that assures adequate cylinder cooling, or the baffles and baffle seals have been neglected, the rings may be very slow to seat. If this results in excessive oil consumption, the only remedy is to remove the cylinders, break the glaze, and start over.

THE FIRST FLIGHT

After turning onto the runway, slowly increase the rpm to the normal magneto check speed for your airplane and switch from both to left, back to both, and then to right. As long as there's no backfiring or a serious rpm drop off, you're good to go.

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Don't push the throttle all the way in until the airspeed needle has gone through 40 mph. After 40, gradually (taking three or four seconds) push the throttle all the way in. Scan the engine instruments for any abnormalities. Make a note of the EGT number on one cylinder or the EGT needle position on the instrument face after full power is applied; you'll need that number later.

Pilots flying the first flight on a Continental fuel-injected engine will need to check to see where the fuel flow is during full-power operation. Per engine break-in instructions from RAM Aircraft, a company that specializes in high-quality rebuilds of

After climbing to a safe altitude (not so high that 75 percent power is unattainable), level out and pull the power back to 75 percent.

uel-injected Continental engines, if the fuel ow is more than 1 gph (6 pounds) off target rom the values specified in Continental ID97-3G, pull the power back and abort the akeoff. Make the proper adjustments before aking off. Fuel flows that are too low will ause high temperatures.

During climb, select a gradual climb pro-le to maximize cooling airflow. Leave the owl flaps open and mixture rich.

Recommendations vary slightly among anufacturers about when to reduce power. oth Lycoming and Continental Motors say his should occur during climb. ECI and AM say to reduce to climb power by reduc-ng the manifold pressure as soon as ractical (RAM says takeoff manifold pres-ure should be limited to 30 inches), but on't pull the propeller off the high pitch top until after 10 minutes of flight.

After climbing to a safe altitude (not so igh that 75 percent power is unattainable), evel out and pull the power back to 75 percent. The mixture should not be leaned more than 125 degrees rich of peak. RAM suggests doing this by noting the takeoff EGT indication, and leaning back to the same indication during level cruise flight.

Lycoming recommends that the break-in flight be completed by increasing power to full rated for an additional 30 minutes before returning to land.

During descent, gradually reduce power to achieve a 300 to 500 foot per minute descent. Do not push the mixture to full rich — gradually richen as necessary to maintain the same EGT that was noted during 75 percent power cruise flight.

The critical time in the break-in of a new engine starts the moment the engine is uncrated and doesn't end until the second hour of flight.

Lycoming and TCM recommend that break-in will be best accomplished if power settings are maintained between 65 and 75 percent for the first 50 hours of flight.

The critical time in the break-in of a new engine starts the moment the engine is uncrated and doesn't end until the second hour of flight. If it's done right, good things happen — if any steps are neglected, you'll pay and pay and pay. EAA

Steven Ells, EAA 883967, is an A&P mechanic, commercial pilot, and freelance writer. He flies a Piper Comanche and lives in Paso Robles, California.

ALL-IMPORTANT FEEDBACK

I READ THE ARTICLE by Steven Ells ("The All-Important First Start," Workbench, March 2017) about making devices out of plastic pipe for pre-oiling engines prior to start. He indicated they are to be used up around 50 psi. This is a very dangerous idea as PVC and other plastics are not rated or safe for compressed air service. I have been involved in accident investigations where plastic pipe has come apart explosively and sent shrapnel for a long distance. His quoted pressure rating for PVC is for liquid service only, which does not expand explosively upon pipe failure.

Take care and be safe.

Burl Skaggs, EAA 480138
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Three readers wrote telling me that due to the possibility of strength loss due to aging, reductions in strength due to stress risers from cutting threads, and the weakness of glued joints that PVC pipe — even pipe rated for 220 psi — should never be used in pressurized air applications. When PVC pipe fails under air pressure it explodes like a bomb, radiating outward in jagged shards.

Again, thanks for your help and expertise.
- Steve Ells

"The All-Important First Start" shows the engine running without its cowling on! This is the quickest way to ruin an otherwise good engine. The engine should never be run without the cowling in place according to the manufacturers of Continental and Lycoming. Hot spots develop very quickly and can spell doom for the engine.

Ted Hall, EAA 852248
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He is absolutely correct — some sort of engine cooling must be installed if there's any power at all developed during a ground run. In addition to re-installing the cowling, it's permissible to conduct ground runs using a ground cooling plenum. When the photo was taken the engine was being run at low power (1200 rpm) following the after-installation visual inspection for a leak and magneto grounding check. Run time should be no more than two minutes. If there are no leaks, install the cowling and commence with the break-in flight. - Steve Ells

I would like to make a small comment regarding "The All-Important First Start" in the March issue of *Sport Aviation*.

While pre-charging the oil system on a fresh engine is preferred, it is not always available to everyone. Just as important, during an oil and filter change, until the oil filter is filled, no pressurized oil is being supplied to the bearings and other components. Being in the racing engine business, I recommend that the oil filter be filled with oil prior to installation. While that may not be practical on horizontal mounting, the filter element should at least be saturated prior to installation.

I also concur that ignition not be activated until positive oil pressure is observed.

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Innovation and Interesting Jobs

Both of Beth Stanton's articles (Innovation's "Practical Solar" and "Cool Flying Jobs," March 2017) are certainly interesting, showing how flying can embrace new wrinkles in the fabric of flight.

Solar power certainly has potential along with bat-