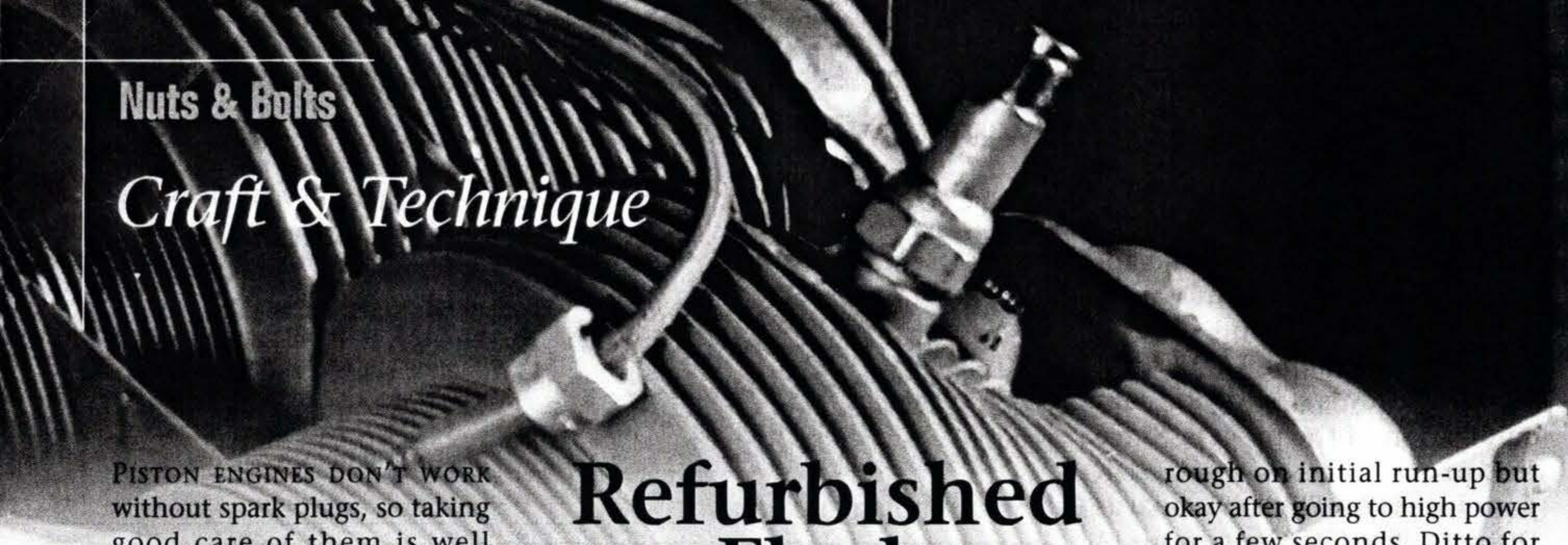

Refurbished Flash

Servicing your spark plugs

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PISTON ENGINES DON'T WORK without spark plugs, so taking good care of them is well worth the effort. It's also something owners of certificated airplanes can do because "replacing or cleaning spark plugs and setting of spark plug gap clearance" is on the list of FAA-approved preventive maintenance items.

In servicing a spark you remove contamination and restore the proper electrode gap. Carbon, lead, and silicon deposits collect in a plug's firing end during normal engine operation, reducing its efficient operation. And each spark removes a little metal from the electrode, increasing the gap, and a larger gap degrades the plug's optimal operation.

Spark plugs are designed to work in a stressful environment, but they are delicate, and mishandling and minor abuse can easily damage them. To remove the plugs loosen the lead terminal nut with an open-ended wrench, and use a second wrench to keep the wire from rotating. When the terminal nut is loose, unscrew it by hand.

Many terminal nuts are aluminum, and using the wrong wrench or cross-threading can easily damage them. After unscrewing the terminal nut, pull the lead wire terminal straight out of the plug cavity. Some leads have ceramic insulators, and any side load can crack or break them. Tuck or tie down the lead terminal in a clean area away from the plug. Do not get oil on it.

Remove the plug with a deep six-pointed socket wrench. (Most automotive spark plug wrenches are not deep enough.) Be careful not to drop them because that will crack the insulator; if you drop a plug—replace it with a new one.

You must be able to identify each plug by its cylinder and position. This enables you to "read" each one for the condition of that cylinder and to rotate them properly during reinstallation. You can make a plug holder out of a bread pan: Turn it over, drill the appropriate number and size holes, and label each one.

Inspection

After removing the plugs, inspect them closely. Look for inconsistent colors and deposits between the cylinders, tops and bottoms. A dull brown deposit lightly covers a normal plug and doesn't fill the cavity around the center insulator. The electrodes will show wear with a slightly wide gap. Replace a plug if the center or side electrodes are half their original dimensions.

A black fluffy surface deposit indicates an over-rich fuel/air mixture. Check the cylinder's other plug to confirm the situation. Glossy black, wet, or oily deposits on the electrodes or insulator tip are a sign of oil contamination. Oil could be getting past the intake valve guide or worn (or not broken-in) piston rings.

At low temperatures oily deposits can foul out the plugs during a mag check. This is why the plugs may be rough on initial run-up but okay after going to high power for a few seconds. Ditto for plugs that seem to be rough before flight but are okay after the flight. Hard brittle gray deposits, sometimes seen as round balls, indicate lead fouling. This is caused by the lead in 100 LL and the plug running a too cold or too rich mixture.

A shiny, dark brown deposit on the tip denotes silicon contamination. Dust or sand sneaking past the air filter meets lead in the combustion chamber and forms lead silicates. At low temperatures lead silicates are insulators, but when hot they are conductive and leak voltage to ground before it's strong enough to jump the electrode gap.

Cleaning

Before removing the contaminants, degrease the spark plugs by putting them electrode-side down in a metal rack and soaking the firing ends in a solvent (Stoddard, Varsol, naptha, or mineral spirits) for 20 minutes.

Do not get solvent in the plug's terminal end (where the ignition wire goes). This can contaminate the terminal cavity and lead to shorting from the ignition lead to ground. After soaking the firing ends, drain and blow-dry with compressed air.

Now remove the hard contaminants. A vibrator-type cleaner makes the job easy, but it's expensive. Hand scraping takes a bit longer, but it works almost as well. Make a scraper from an old hacksaw blade.

With a bench grinder create a probe 1/8 inch wide and an inch long. Leave the edges sharp and square. Taper the tip a bit to get into

the plug's bottom crevasses. Wrap the "handle" with tape to protect your hand. When scraping away the deposits, be careful of the center insulating ceramic support for the firing tip of the plug. It will break if you pry on it excessively.

After scraping, remove the residue you couldn't get with an abrasive blast using glass beads or aluminum oxide abrasive (silica sand contaminates the plug, causing it to short). Don't blast for more than a few seconds because too much blasting removes working material from the plug, reducing its life. Blasting damages more plugs than it helps, and I don't blast plugs that aren't fouled badly.

Use a felt or cotton swab soaked in acetone or MEK to clean the plug's terminal end. If the solvent leaves some carbon traces in the cavity, polish out the stain with a fine abrasive, such as Bon Ami, on the swab. Do not use sandpaper. After a final solvent washout, blow-dry the cavity.

Clean the threads with a fine wire brush. A power-driven wheel will also work, but don't get too aggressive, especially on the rest of the plug. If the plug is rusty, remove the rust.

Gapping

Adjust the gap on a massive electrode plug by moving the ground electrode so it's parallel to the center electrode at the specified distance, usually 0.016 to 0.021 inches (check the specific values for your plugs).

You'll need a gapping tool. I use the CT-415AV model that Aircraft Spruce & Specialty sells for $85. You also need a wire gap gauge to measure the distance between the electrodes (CT-450 at $13). You cannot use standard flat feeler gauges because they won't fit the circular gap.

When you press in the ground electrode to adjust the gap, it will spring back about 0.002 inches when you release the pressure, so you need to over push it to account for this. But don't over bend the electrode; discard the plug if you do. Reverse bending weakens the ground electrode, and you don't want it to break off in use and rattle around in your cylinder or stick under a valve.

The gapping procedure is the same for fine-wire plugs, but you'll need a different bending tool (CT-457 at $25). The ground wire is brittle and easy to break, and the reverse-bending rule still applies. Considering the price of the plug, set the gap carefully, in small increments, and with no distractions.

Testing

Proper service includes testing the plug under pressure. The most common tester is a cleaner/tester called a "bomb" tester. Screw the plug in the tester finger-tight, allowing pressurized air to leak out.

The tester applies high voltage to the plug, and you can see the firing tip in a mirror. As the air pressure is metered into the firing chamber, note the pressure at which the plug stops firing. To assess satisfactory operation compare this pressure to values on a chart for various gap settings. Generally, if the plug fires above 100 psi, it will usually work successfully.

If you don't have access to a bomb tester, you "test" them on the first post-maintenance engine run-up. A multi-probe EGT/CHT system will quickly identify any weak plugs, particularly on single mag checks.

Painting & Storage

I paint my plugs, particularly if I had to remove corrosion. Mask the threads, stand the plugs on their lead wire end, spray them with a thin coat of charcoal grill paint, and let them thoroughly dry. I've seen others use high-temp auto paints and regular Rust-Oleum with success.

When dry, remove the masking. If you used a Rust-Oleum type enamel,

bake the plugs in an oven at 250°F to set the paint so it won't chip. If you don't fly a lot and the plane is not hangared, painting the plugs will increase their life significantly.

If you don't plan to immediately use the plugs, lightly coat the bare metal parts with oil, put them in airtight containers similar to what new plugs come in, seal them in the containers, and store them in a dry spot.

Rotation

Because a magneto fires the plugs and the polarity of the magneto pulse reverses at each firing, the polarity remains the same for any given plug because engines have an even number of spark plugs. This polarity causes either the center or the ground electrode to wear, and rotating the plugs evens the electrode wear, extending their life.

When rotating a plug it needs to go to the next position in firing order and be swapped top and bottom. Four-cylinder engines fire either 1-3-2-4 or 1-4-2-3, and most six-cylinder engines fire 1-6-3-2-5-4. Lycoming gives the firing order on the left side of the case, and Continental gives it on the engine's dataplate.

After noting your engine's firing order, from your tray take the top plug from Cylinder 1 and screw it into the bottom of the next cylinder in the firing order, and put the bottom Cylinder 1 plug in the top hole. Repeat this for the remaining cylinders.

There are other rotation systems, such as swapping all tops for bottoms, and then 1 and 6, 2 and 5, 3 and 4, or for four-bangers 1 and 4 and 2 and 3, and they work. But the first system moves the plugs through various cylinders, evening out the wear caused by a "harsh" plug location.

Reinstallation

Lightly coat the plug's threads with an anti-seize compound before reinstalling them. New plugs come precoated, I'm told, but you can add some to be sure. To avoid getting compound on the electrodes, which can foul them, I skip the first whole thread below the electrodes and very lightly coat the remaining threads.

Put a new solid copper gasket on the plugs. Reused gaskets can become brittle and fail to give a good seal, so 15 cents for a new gasket is a cheap price to pay for a sure seal. If the plug location has a CHT ring, this gasket-like probe replaces the gasket.

Make sure the cylinder threads are clean and then screw in the plug by hand, not with a wrench, which increases the chances of cross-threading the aluminum cylinder head (a problem you have to re-

move the cylinder to repair).

You should be able to screw the plug all the way in by hand. If you can't, there's probably some carbon in the threads. You can remove it by carefully screwing a thread-cleaning tool into the hole or, if you have sharp eyes, with a small wire brush or a dental pick. If the helical thread insert is bent or distorted, call for professional help—and you may avoid having to pull the jug for repair.

With the plug screwed in hand-tight, use a properly calibrated torque wrench with the correct deep socket to apply the correct torque and tighten the plug in place. I prefer a bending-beam torque wrench because it's reasonably priced and holds its calibration. Snap-over torque wrenches are expensive and susceptible to large errors due to dirt contamination and even temperature changes.

Correct plug torque depends on your engine, and its maintenance manual gives this figure. Generally, you torque Lycomings to 30 to 35 foot-pounds, Continentals to 25 to 30 foot-pounds, and old 14 mm Franklins to about 20 foot-pounds. Never tighten the plugs without a torque wrench. Over torquing plugs can create problems that will make the torque wrench's cost seem trivial.

Before connecting the wire terminals wipe or dip them in a good degreaser (acetone or MEK) and make sure they are dry. Without touching the wire lead below the nut (because your greasy fingers will contaminate them) insert the lead in the plug and hand tighten the nut. There are two sizes of nuts, regular and all-weather, and the plugs must be compatible with the nuts.

Take care not to cross-thread the lead nuts because a new ignition harness is the fix. With the nuts finger-tight, use a wrench to tighten them to no more than 1/8 turn, holding the wire with a second wrench.

Do not over torque the nuts. This makes them difficult to remove next time and wears them out. Over torquing is such a problem one harness supplier uses plated steel nuts. Time will tell whether the improved durability will be worth the increased chance of corrosion.

Checking Your Work

Check the plugs' operating after reinstalling them, especially if you didn't bomb test them. Perform a normal engine run-up and check for smooth operation on all magneto settings—both, left, and right.

If you have a multi-probe EGT/CHT, you can quickly spot a cold cylinder (and a weak plug) on the left or right mag setting and a hot cylinder on both. Many things can affect plug operation, but if the plugs worked before servicing, expect everything to be better after servicing.

Finally, record your work in the maintenance logbook, noting anything of future interest, like fouling in a particular cylinder, which can help you troubleshoot future engine problems.