Spark Ignition Troubleshooting

by Bob Angel

Let's assume you have an erratic engine run. If you have a mechanically solid spark ignition engine there are usually just two causes of ragged running-fuel or spark. A trained ear can usually identify the stuttering miss of an intermittent spark. The engine runs almost at full speed with an occasional complete cutout. Expect anything from a plug change to complete dissection of the ignition system to find the cause.

A weak spark will often imitate a fuel problem by responding temporarily to needle valve tweaking but won't hold a steady setting, and it can be hard to tell the difference. So we'll keep an open mind when the symptoms appear to be fuel related.

The biggest single source of problems is failed solder joints. I've had very few failures of coils, transistors, or even condensers. I recently had my first failure of a microswitch. And NiCd batteries go out, but usually just by dying slowly. We'll make up a first law of ignition systems right here: "A wire never breaks in the middle."

Wiring failures occur at unsupported stiff sections around solder joints. Vibration is the main culprit. If you solder good joints and support each one, it will be much stronger. That 10K ohm resistor in the high tension line to prevent radio interference has been the most consistent failure, so I've worked on improving it.

I've gone from 1/4 or 1/2 watt resistors to 1 or 2 watt because they have larger wires. 1 install the resistors with at least a 1" section of flexible wire between them and the spark plug clip. I splint the resistor with a length of toothpick extending past both solder joints, potted and encased in clear shrink tubing.

Spark plugs suffer from vibration, and you need to protect them and the resistor. Those old Champion plugs will shake their center electrode loose if you use a heavy alligator clip on them, so use a lightweight wire clip.

When the high tension in-line resistor fails, the engine will often continue to run, with the spark jumping two gaps, one at the resistor break, and another at the plug gap. The engine may run, but it's likely to be intermittent, causing severe radio interference.

An intermittent connection anywhere can cause radio glitching to the point of control loss. Luckily the cutoff switch will usually function well enough to shut down the engine.

An ohmmeter is useful in detecting the resistor failure. Make an end to end check of the high tension wire, while you pull and wiggle the connections. If you can't get access at the coil end, push a pin into the wire and connect to that. If your ohmmeter blew out and your eyeballs lit up, you should have turned the system off. Serious contest fliers carry a spare high tension lead.

Resistors can also fail internally. It would be rare, but the resistor could possibly show both continuity and proper resistance when cold, and open during a run. Substitution would be about the only way to find this problem. The higher wattage resistors mentioned above would be less subject to internal failure.

Robert Shoebridge, New Zealand. Schmaedig Stick is one of the author's favorites because it makes good test bed for different engines. Photo by the author at Eldorado Dry Lake, 1997 *SAM Champs.*

Continuity light. Here's the first handy tool for the troubleshooting kit: Make up a simple continuity light consisting of a C or D cell with a 1.5v flashlight bulb wired in series and taped to the cell. Solder it all together with a pair of 10" lead wires with alligator clips. Touch the clips to a pair of wire ends and if there's continuity, the bulb lights. You could use an ohm meter for this, but in field conditions the light is much handier.

The main use of the continuity light is to see if the points are working and the timing is correct. With the ignition system off, clip one lead of the light to the insulated point and the other to engine ground. You can usually get a close idea of the piston's top center position by pulling the prop up on compression. Note the position of the prop, then move the blade backwards and stop when the light comes on.

You've just found where the points will break, and you can estimate the prop's angle between points breaking and top dead center. Some basic information: the plug fires when the points break (open), not when they close. The prop should show a difference of 20 to 45 degrees (spark advance) for the engine to be expected to start. If you're hand starting as you should with most sparkers, you'll want to retard the spark below 45°.

Using the test light, I've quickly found drive washer cams installed in the wrong position. A Brown Jr. cam can be installed in 4 positions, 3 of which are wrong.

A Super Cyke, being a more advanced engine can have it's cam installed in only one wrong position of two possible. You can also estimate degrees of dwell by rotating the prop and noting positions as the light flashes on and off.

And if you're setting the advance on an engine such as a McCoy, where the points will be locked down and a starter used, the continuity light becomes even more essential when you're watching a degree wheel while at the same time setting a precise advance to let's say 44°.

Here is a simple test to see if the airplane's ignition system is the problem. Just install a glow plug and see if the engine runs. If it runs on a glow plug, you just might be onto something. It may not run as fast on glow as ignition, because you can't control the timing as precisely.

We'll describe a clip-on ignition set in a later installment. It can be used for engine break-in or for field testing to see if the on-board ignition system is at fault.

We welcome reader contributions of any peculiar experiences or tips you'd like to share. RLA

Spark Ignition Troubleshooting, Part II

by Bob Angel

We now have fewer spark plug problems than we did in the old days, and by using NiCd cells and transistor ignition systems, plug life has also been improved. But plug problems still occur, and one of the easiest things to check when the engine goes sour is to swap a known good plug into the system. Not necessarily a new plug, but one you've previously tested. Even new plugs can have a hidden flaw.

Timers (breaker points) have several possible failure modes, some of which can be tough to identify. If a timer problem is suspected, first hook up your trusty continuity light.

One clip goes to ground and the other to the insulated point. The lead from the airplane's ignition system to the point can be left attached but keep the system switched off. Turn the prop through and watch for the light to indicate points closing and opening. The bulb should light during the piston down stroke indicating point closure and the start of dwell, and should go off about 45' or less before top dead center. If the light stays on continuously, remove the on-board system's wire to the point and try again.

If the light still stays lit continuously, it indicates a short in the points or points not opening. If the light never lights, there is an open circuit caused by points not closing, poor timer to engine ground, etc.

A second test is simulating point operation to tell you if the rest of your ignition system is operating. Take a coarse file and two test leads with alligator clips on each end. Attach one lead between the file and engine ground. Be sure the points are open. Attach the second lead to the insulated point, and clip some sharp edged metal object such as a short piece of piano wire to the lead's other end.

We're going to switch the ignition system on and rake the piano wire across the file to simulate point operation. But first the high tension lead needs to be removed from the plug and positioned near engine ground to see if the spark is jumping.

If you get a good continuous spark when you scratch the file, it shows the rest of the system is probably working and you may have a point problem. Maybe, but if you can't get a good series of sparks, you now have a stronger clue that the problem lies outside the points.

Jim Adams had an erratic running Brown Jr. which had the modern Hurleman type timer. It turned out that the riveted-on moving point had loosened ever so slightly and was only making intermittent contact. Jim soldered the point to its spring and then he soldered the other end of the point spring also, because it's just crimped to the timer frame. After Jim's experience, I did the same thing to my Brown Jr., just for insurance. A problem like this might escape detection with the test light.

Henry Smith of SAM 21 used a strip of copier paper to clean his points. Henry had stuttering problems until he found that the copy paper had put a coating on the points. John Richmond of SAM 26 stored his engine with a piece of absorbent paper closed in the points to soak out oil. But John missed a flyoff when a small speck of the paper stuck between the points during removal.

I was getting ragged runs on a McCoy 60 and found that the fiber cam follower had been slightly overlapping the cam drive area on the crankshaft, and was running partially on the solid crank edge. Filing a few thousandths from the edge of the follower fixed it. You often need a magnifier and very careful inspection for this sort of thing.

"Point float" has always been a source of worry, but its actual occurrence is fairly rare. Point float can occur when the moving point spring is too weak, the RPM is high, and possibly the dwell (closure time) ground into the cam is short. The idea is that the cam grind drops away from the cam follower faster than the moving point can follow, so the points close late, giving short dwell and weak spark.

Point float would be a possible cause of a rough running engine. If you suspect point float just pull the moving point open and compare its spring pressure to a couple of other engines. Most engines have more than enough spring pressure to prevent float, and excess spring pressure just creates drag on the engine. I've put a small prop on a McCoy 60 and run it beyond 15,000 with no float. If your engine has been running fine and suddenly develops a miss, I'd look elsewhere before worrying about point float.

Batteries have always been a problem. NiCds are preferred because ounce for ounce they deliver more amps under load, even though dry cells may show higher no-load voltage. And since dry cells must be replaced often, they are more likely to be used in a spring loaded battery box, instead of being soldered together. Battery boxes are notorious for failures. Think about how often a flashlight fails for no other reason than poor battery connections.

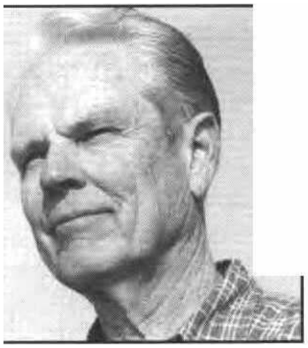
We've found that 3 cells greatly improve reliability over 2 cells. If you need to save weight, go to 3 smaller capacity cells. For our use, 270 mAh cells are quite adequate, and can be used in a transistor system without boosters. If you go any smaller, it would be a good idea to use a booster for starting. I once stripped down a 9V rechargeable battery, hooked up 3 of its tiny cells to an ignition system and ran an O&R 23 for about 9 minutes before it began to miss.

Ignition service is more severe on batteries than radio use, so expect to replace the cells more often. A year or two is about the expected life of a 270 mAh battery, and smaller ones will go much sooner. You should get over 4 volts with a light load on a freshly charged 3 cell NiCd pack, and around 3.6 V or less, you may begin to get missfire.

You can buy neat little 270 mAh, 3 cell packs made for telephones. Buy only ones with cylindrical cells. I tested the disc shaped button cells and got very short life. Besides, the button cells are unvented and could crack or even explode if fast charged. SR Batteries can make up 3 packs in almost any capacity, even down to 150 mAh. RLA

Spark Ignition Troubleshooting Part III

by Bob Angel



A real help in isolating ignition problems is a clip-on ignition system. You can use it for bench running or hook it up to an airplane quickly to see if the on-board ignition system is faulty.

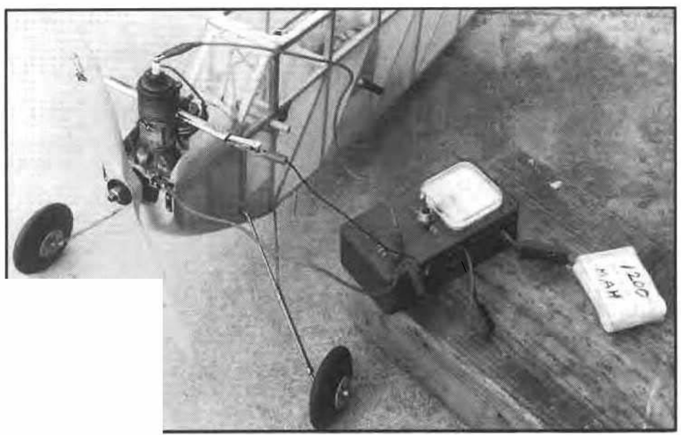
The clip-on can be a simple, wired-together set of coil, batteries, etc.; with three connectors for ground, points and spark plug. Or it can be a more elaborate enclosed unit incorporating an ammeter.

In the August 1985 issue of Model Aviation, Bill Schmidt, as a guest in D.B. Mathews' column, published a clip-on ignition set housed in a Tupperware container. The article has some worthwhile text, photos, and a schematic. It's available through the SAM library. The schematic, as published, had one small omission, that of the ammeter. The 0-5 amp ammeter is placed in series in a battery lead. Be sure to observe proper polarity.

I had built my own version of such a set shortly before Bill's was published; Poor timing. Too late to "scoop" Bill and too early to take advantage of his advice. But the designs are essentially the same, other than a few small details. Bill used a push-on, push-off switch which he felt he could slap off faster for emergency shut down. I prefer my toggle switch to see at a glance whether the switch is on or off.

Bill put the battery inside the box, but I left mine outside and use Sermos connectors, so I can use different batteries.

Bill prefers the switch in the points-lead where the current is less. I don't trust a transistor not to leak, so I switch mine off at the battery.



Bob's clip-on ignition system for troubleshooting on-board components and wiring. Switch off the internal system first. If the motor runs properly with the clip-on attached, it's a pretty good sign there s something wrong with the internal system. In the text, Bob explains how to diagnose the situation using this device.

On the pictured box you'll notice three pairs of Sermos connectors at the right. The top pair is battery input and the bottom pair goes to points and ground. An auxiliary battery is usually used to power the clip-on set, but I can also plug in the plane's ignition battery to power it. That can give you a clue about condition of the on-board battery. The static, points-closed ammeter reading will drop as battery current drops.

The middle pair of Sermos connectors are "amps out" leads which go through the ammeter (un-switched) so the meter can be used separately from the ignition system.

When using the clip-on set, the ammeter needle pops up when the points close, letting you know how they're operating. As you gain experience, you'll learn to recognize battery condition by current flow with points closed (usually 2 to 4 amps), and what normal readings should be when the engine is running (usually 1 amp or less) .

Spark plug: Substitution of a known good plug is easy and about the only way to find a bad plug.

Points: A continuity light or ohmmeter clipped to the points can tell you if points are shorted, open, or operating normally. You can also estimate dwell, find a cam positioned wrong or estimate degrees of advance. Add a degree wheel to the prop shaft, and you can find exact dwell or advance. You can do similar things with the clip-on ignition set by watching the ammeter, but it's not a good idea to leave the points closed too long with the spark system hot.

On board ignition system: If the engine runs OK on a glow plug, it indicates an ignition system problem, not a fuel feed problem. If it runs OK on a clip-on ignition set, you know points and plug are OK, and the problem is in wiring or ignition components. If you lack a clip-on set, the coarse file mentioned in Part II (SAM Speaks #144) can be used for breaker point simulation, which can tell you if the on-board components are producing a reasonable spark.

Coil: Make an ohmmeter check through all three coil terminals and compare with a known, good similar coil. This should reveal an open internal circuit, or shorted windings. Melted wax from inside the coil is a sign that it has been overheated, but I've seen coils with this symptom which still operated well. A common failure mode is an intermittent internal connection.

Condenser: Most transistorized circuits (recommended) no longer use a condenser (capacitor). A few electronic guys have capacitor checkers, but substitution is about as easy and capacitors are cheap.

Transistor: As with capacitors, some folks have transistor checkers, but substitution can be made and a spare is not expensive.

Microswitch: These can show normal operation using a continuity light or meter, but still be erratic from vibration with engine running. You can put a jumper across the Microswitch connections, start the engine, and see if the missing goes away

Electronic switches such as the "E" switch or "Hot Spot" can have their own peculiar problems which we've dealt with in earlier columns. Due to the complexities involved in troubleshooting and frequent returns of good units, Bob Holman (for one) has stopped supplying these.

The hard cases may take lots of wire tugging, close inspection of points with a magnifier, or part-by-part substitution. If all else fails, you can always build a twin pusher. Robert L. Angel, 1001 Patterson Rd., Santa Maria CA 93455.