



August 2013

Tempest Tech-Tip 0813

“Light My Fire”

Background

Without a good spark, spark plugs can't get the job done well. How do you keep good sparks coming, so your spark plugs can 'light your fire' with a bang?

Magnetos still power most aircraft ignition systems, see Figures 1 & 2



Figure 1
BENDIX MAGNETO



Figure 2
SLICK MAGNETO

The magneto delivers sparks to each cylinder in the right sequence and at the right time. The magneto's spinning magnet creates strong magnetic pulses in the ignition coil, see Figures 3 & 4.

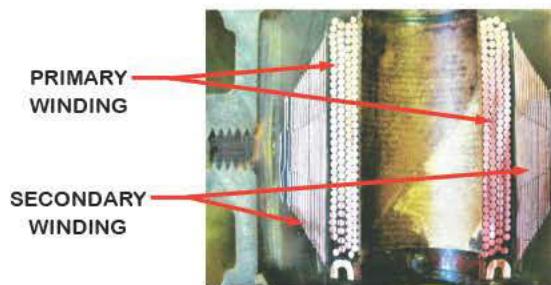


Figure 3
SECTIONED COIL ILLUSTRATING PRIMARY
AND SECONDARY WINDINGS



Figure 4
MAGNETO COIL





At the peak of each pulse, the contact points open, causing the flux field to collapse (see Figures 5, 6 & 7) at almost light speed. The collapsing field cuts through thousands of secondary coil windings, creating a tremendous voltage spike, see Figure 8.



Figure 5
MAGNETO WITH COIL AND POINTS



Figure 6
POINTS SHOWN "OPEN"



Figure 7
POINTS SHOWN "CLOSED"

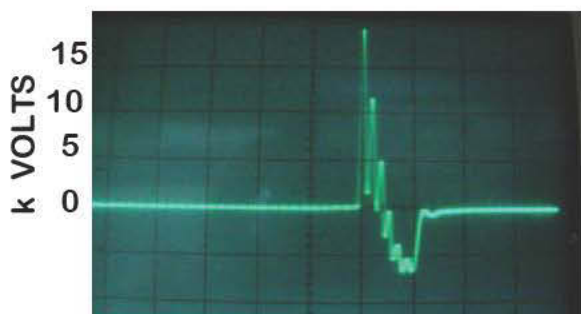


Figure 8
OSCILLOSCOPE OF SPARK PULSE
(FILE PHOTO FOR REF. ONLY)

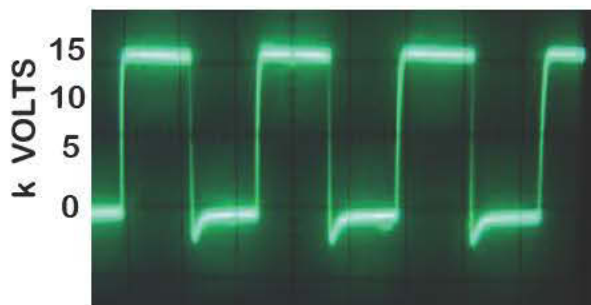


Figure 9
OSCILLOSCOPE OF SQUARE WAVE
(FILE PHOTO FOR REF. ONLY)

The pulse of energy goes to a specific spark plug. There, the energy 'piles up' against the spark plug's resistor. When it builds to a certain level, it rushes through the resistor and arrives at the spark plug's center electrode. Alas, there it encounters the spark plug gap. Again, the energy piles up. When it reaches about ten to twelve thousand volts, it 'jumps the gap' as a spark. That's the spark that 'lights your fire'.





Before the laboratory guys jump my case, the above explanation is simplified. But, getting too far down into the weeds serves no purpose for this discussion.

The spark needs to start and stop suddenly, see Figures 8 & 9, to avoid unnecessary stress on ignition system components. For the electronics guys, that would be a perfect square wave pulse with zero rise and fall times. We can't get that with a magneto, but we can trim the ends of the magneto's spark enough to serve our purposes.

Troubleshooting a Rough Running Engine

Of course, the overall condition of the magneto, contact points, capacitors, "P leads", distributor gears and fingers, distributor block terminals, ignition leads, and the spark plugs themselves all play roles in assuring a hot spark. Following are some hints that may help you resolve a rough running engine problem and keep your ignition system in top shape.

Loose magneto bearings cause shifts in the magneto's internal timing. There should be no identifiable radial or axial play in the magneto bearings/shaft. If the magneto shaft is loose, you'll have little success smoothing a rough running engine until that's fixed.

Contact point surfaces must be reasonably smooth. If a peak and valley exists, see Figures 10 & 10a, the points don't open suddenly. Without a clean 'break' at the points, the nearly instantaneous collapse of the primary flux field necessary to produce a high voltage pulse in the coil's secondary and a strong spark doesn't occur.



Figure 10
EXAMPLE OF "UP PEAK"
(FILE PHOTO FOR REF. ONLY)

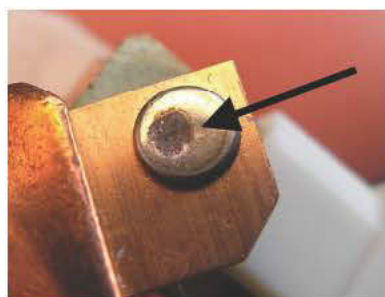


Figure 10a
EXAMPLE OF "DOWN PIT"
(FILE PHOTO FOR REF. ONLY)

A peak pulling out of a pit in the contact point faces is like a piston sliding out of a cylinder, dragging on the walls as it goes. That creates a series of small, intermittent electrical pulses in the coil instead of a sharp, clean collapse of the circuit





and the attendant magnetic field. Smooth peaks with a stone or file, or replace the contact set if more than minor smoothing is required. Pay particular attention to removing the high points. The pits don't cause much of a problem without a peak to rub inside them.

Capacitors (condensers) act to suppress arcing at the contact point faces when they open, see Figures 11 & 12. Bad capacitors cause weak sparks, excessive contact point arcing, rough running, and hard starting.



Figure 11
 "ARCING WITH CAPACITOR"
 (Tiny White Dot at Tip of Arrow)



Figure 12
 "ARCING WITHOUT CAPACITOR"

In 2000 and 3000 series Bendix type dual magnetos the capacitors are mounted in the harness covers. Often, they end up staying on the airplane when the magneto goes to the shop for overhaul or repair. Thus, they just get reused, over and over. Always check the value of the capacitors when you work on magnetos. The burned up points with melted cam pawls that you replace time after time and can't figure out why are probably the result of bad capacitors or P leads.

"P leads", particularly in turbocharged airplanes, are often damaged by heat. Since the P leads are shielded, you can't see the plastic insulation under the shielding. But if you looked you'd often find a series of short 'doughnuts' of plastic an eighth of an inch (4 or 5 mm) long with cracks between them. When moisture and dirt gets in the cracks they act as a semi-conductor between the conductor and the wire shielding. This alters the capacitance of the system and causes excessive arcing at the contact points.

Excessive arcing heats the spring on which the movable contact is mounted. Then the hot spring melts the plastic pawl. The shortened pawl causes the contact point gap to become narrower, throws off magneto internal timing and causes a weak spark. When the gap gets too narrow the magneto will quit firing.

If you can't seem to find out why you're going through contacts points one after another, check the P lead and capacitors.





Distributor gear fingers and stationary electrodes: Deposits on the end of the rotating distributor finger and the stationary distributor electrodes may hit one another as the gear spins, see Figure 13. If they do, the finger can be knocked loose from the gear. The engine may run fine for a while then go rough and smooth back up. If it does, check for a loose distributor gear finger.

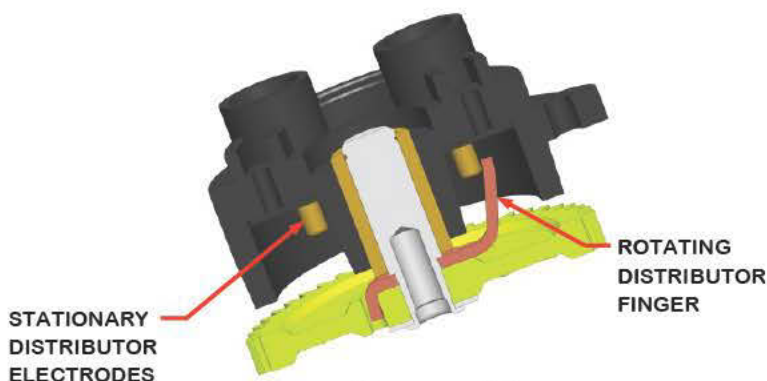


Figure 13
SECTION THRU
DISTRIBUTOR & GEAR

If the finger wiggles relative to the gear shaft, or if the finger and fixed electrodes have been hitting one another, replace the block and gear. Gear teeth could be cracked, the finger to shaft joint could be damaged, or the electrodes in the block could be knocked loose.

Ignition leads: There's no need to go through the normal visual checks here except to say - ignition leads are often bundled together and sometimes they are chaffed deep inside the bundle where you can't see. Without cutting the ties and looking at the individual wires, you won't find the chaffed spot that is killing the spark and causing the rough running.

Checking the leads with a high voltage megger instead of a low voltage Ohm meter will often find chaffed weak spots in the insulation that a low voltage meter won't.

The 'cigarettes' on the tips of the ignition leads, see Figure 14, must be clean. When a plug fires, a corona develops at the junction of the lead wire spring and the terminal in the spark plug lead well. Consequently, deposits form on the cigarettes and inside the spark plug well, see Figure 15. The spark may jump to ground through them and cause rough running.





Figure 14

'CIGARETTES' ON TIPS OF IGNITION LEADS



Figure 15

COMPETITIVE PLUG WITHOUT FIRED IN RESISTOR

Solvents such as lacquer thinner or toluene are good for cleaning the cigarettes and inside the lead well. Use the corner of a rag on a small screw driver tip to swab inside the lead well. Don't pry against the ceramic insulator. You could break it. Just wipe the surface deposits off. Rinse and dry the plug with compressed air. Don't try to get every trace of stain out of the well. You can't, and it's not necessary. See Tempest® Tech-Tip "Changing Spark Plugs" for additional guidance on spark plug cleaning.

Spark Plugs: Typically, the gap is re-set on massive electrode spark plugs about every 50 to 100 hours of operation. Everybody pretty much knows how to do that. For fine wire iridium plugs, setting the gap is rarely an issue.

Iridium melts at such a high temperature that not enough burns away during the life of the plug to matter. If you do try to bend the fine wire ground electrode, you'll probably break it. If you have a Tempest® iridium plug with a questionable gap, call us. If necessary, we'll repair or replace it.

Bad spark plug resistors cause hard starting, misfiring, and rough running. You can check resistance with a low voltage ohm meter. Place one lead in the lead well on the terminal where the cigarette spring sits and the other on the center electrode. Polarity doesn't matter. If the resistance is above 5000 ohms, the plug might be causing problems. Tempest Tech-Tip Changing Spark Plugs provides more detailed information about spark plug resistance and checking it. If you find a Tempest® spark plug with resistance above 5000 ohms, call us. Return it to us and we'll replace it free. Or, you can use a Tempest® AT5k™ resistance checker, see Figure 16, to check the plugs.





Tempest® will try to help with any ignition, fuel or related problem you have. Feel free to call us. We want your plane to run right and run long. Tempest® will 'light your fire'.



Figure 16

Tempest® AT5k™ Resistance Checker

Additional Information

For additional information on this Tempest Tech Tip and Tempest products, please go to www.tempestplus.com or call (800) 822-3200.



www.tempestplus.com

