FACTS OF SPARK IGNITION ENGINES

By Bill Schmidt

Published in the January 2013 issue of the Wichita Historical Aircraft Moderers newsletter, Jeff Englert, Editor

I have come to notice that very few people know the following facts and information about model engine spark ignition operation. I have spoken to many folks about it and it takes a lot of time to do so individually, so I thought I would put it to paper.

What do you know about transformers? Yes, they hang on a pole or sit in a box on the ground behind your house and convert 7200 volts AC to 220 / 120 volts AC power for use in your home. (Transformers use a pair of coiled wires that are usually wrapped around an iron core. Their primary role is to increase or decrease AC voltages. Transformers operate on the principle of induction, in which a rapidly changing magnetic field produces an induced EMF (electromotive force), or voltage. For this reason, they only work with alternating current. The first coil winding is known as the primary, and the other the secondary. – editor) With a volt meter connected across the secondary output windings of a transformer and DC power applied to the primary input windings, the meter will momentarily deflect upscale and then return to zero. When the circuit is opened the voltmeter will again deflect upscale and then return to zero. If the DC power is left connected the transformer will get hot and begin to smoke and eventually fail if not catch on fire. All transformers have voltage ratings for their primary and secondary windings. These windings have more OR less turns in their construction that dictates their input to output voltage performance. A transformer can be successfully reversed for use in most simple operations. An example is of a unit marked 120 vac input that gives 12 vac output. If you put 12 vac on the output you will get 120 vac measured at the input side although not at the same amperage capability as when connected in reverse. You should know that there is usually no connection or electrical continuity between the primary or the secondary windings. This gives electrical isolation between circuits and is desirable in many cases. However, in some transformer construction the primary and the secondary windings are connected at one point in their assembly. There is no electrical isolation therefore between circuits and their intended application specifies this feature. What does all this have to do with model engines?

Model engine spark coils are small TRANSFORMERS. They have a primary coil of about 24 turns of # 20 wire wrapped around the iron core laminates which is also connected to one end of the thousands of turns of the very much finer wire of the secondary winding. Put an ohm meter on a scale of 5000 or 10,000 ohms and touch the output secondary that goes to the spark plug to one of the primary Lugs. You will get a reading of from 1400 to 4600 ohms depending on the quality of the coil. Touching the other primary Lug will give you the same reading. You cannot read it at the scales available, but there will be 2-3 ohms difference between the two readings as one side includes going thru the primary to get to the secondary. A general rule is that the higher the resistance of the coil's seconday, the better the performance you will get in the form of a greater spark.

What about transformers (model coils) not working with dc current when batteries certainly are dc? Well, transformers are kind of neat things. AC current switches from + to –60 times a second in the power grids of most countries and this is what a transformer usually sees. HOWEVER , if you pulse, that is turn off and on, a dc input into the primary of a transformer at a fairly fast rate the transformer sees this as acceptable ac power and functions as such. Large transformers however, must be manufactured specifically for the cycles per second of their intended use to function correctly and our small coils by their design do not have such a tight specification. Turning the power on and off at a rapid rate is the function of the ignition points on our model engines. These point contacts generally see 3 amps of current flow thru them with the action of a capacitor to act as a buffer and keep the burning and pitting of them to a minimum. The advent of my Schmidt Trigger design in Model Aviation Magazine in August of 1985 utilizes a high speed transistor to take the load off of the tungsten ign. points and lets the transistor switch the heavy current. The engine's ignition points then only "tickle" the transistor to get it to switch the power on and off thru the coil. With a small resistor of about 20 ohms on the base of the transistor the ignition points see only about 50 mA of current flow thru them and burning and pitting is virtually eliminated. I tested the circuit back then and it would tolerate up to about 95 ohms resistance (read dirt and oil) in the points tickle circuit before it would cease to switch the coil off and on. The utter simplicity of the design having only one transistor and one resistor has made it universally used by nearly all those who run spark ignition engines.

There are thoughts and articles that the polarity of the connections of + and – of the batteries to the primary terminals makes a difference in the spark output power. The secondary connection is made externally to one of the primary's lugs and the positive (+) should go on that lug for the best voltage output. By carefully removing the solder with a suction tool you can find which lug has the secondary connected to it. I've checked this out and found that this does not always hold true. I made up a ." x4" x14" wooden breadboard circuit with a transistor, a bed for various ign. coils, a Deans plug battery connector, a pair of etter "C" shaped 2" high vertical # 20 wires that can be spaced about ." to 5/16" apart at the top and a ice cream stick wrapped with # 20 bare copper wire with 25 windings spaced about 1/8" apart. Mini-gator clips are used for the various quick connections to coils to be tested. When hooked up hot, I run a test probe up and down the wire wrapped ice cream stick like Jerry Lee Lewis on the piano keyboard and watch the spark intensity. A 3 volt #123 camera battery (cheapest at Wal Mart) is the usual test and flight battery but a 3.7 volt Li Po battery will really make a poor quality coil stand up and talk. The Super Aero Spark and Model Electric coils seem to be the strongest. Changing polarity on the coil being tested is the best way to determine spark output. Watching closely, one can see that the output is better in intensity one way than the other relative to polarity. Mark the coil with a tiny piece of red electrical tape or paint as to the best polarity hook up for the + lug. You might notice that one way the spark path is crooked and wild whereas the reverse polarity give a straight spark path between the vertical wires. There is also a difference in the color of the spark. No one has been able to explain this phenomenon of the people I have talked to. It is fascinating to see. (I know the phone will ring some day with an explanation.)

I do not make or sell my transistor design but there are several folks who do, and their ads can be found in model publications and in the pages of the newsletters of various modeling organizations. Only one supplier of the many gives me credit for the design of the transistorized ignition circuit but others rather seemingly pass it off as their own. I do realize it is in the public domain by this time, but I request no royalty, only the credit for its design.
Bill Schmidt