Rambling on about Ignition – Modern Circuits for Model Engine Ignition

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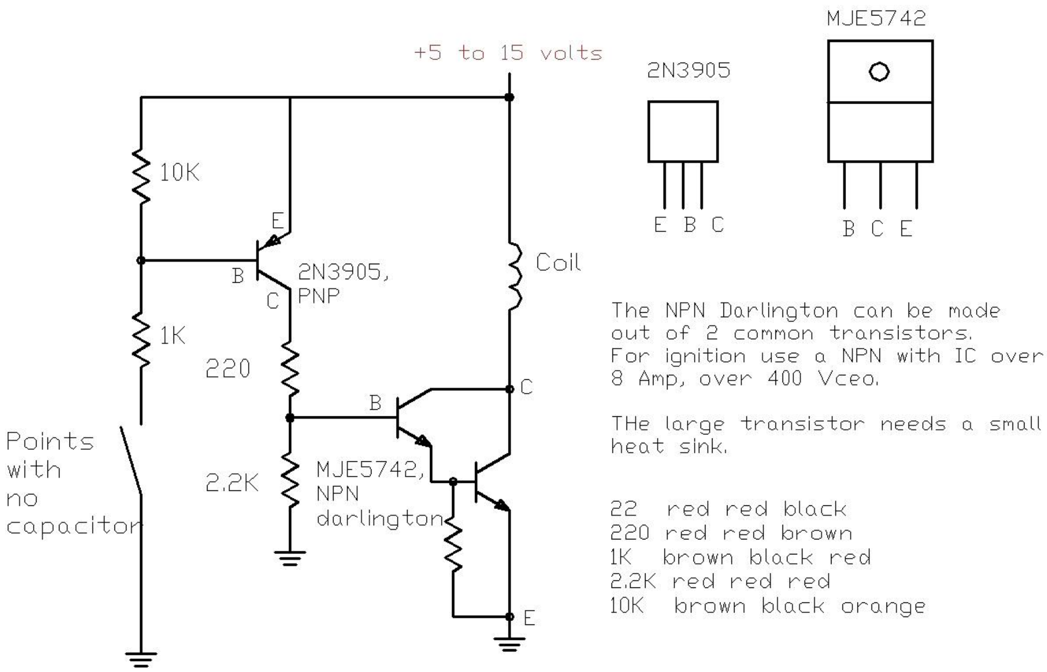
In the last 40 years high voltage spark ignition has changed. Circuits have been optimized, and transistors have been added. The primary focus here is how these system work electrically.

In the last rambling, we discussed how the high voltage ignition using points works and where the high voltage comes from. There are several areas where this performance can be improved mostly with low tech circuits.

Most of remember cars with 6 volt ignition, and were pleased to see it replaced with more reliable 12 volt systems. Automotive ignition coils for 6 volt operation were common, lots of companies manufactured them, and they worked great. If the standard auto ignition coil was operated on 12 volts is would quickly over heat and fail. In DC circuits, if you double the voltage the load power quadruples. The cheap quick fix is put a resistor in series with the coil whose resistance is the same as the coil. Then half the voltage is across the coil and the other half is across the resistor, the current remains the same and the power to the coil remains the same. The coil stores energy based on the current flowing trough it so the exact same energy is available for the spark. The same result could be obtained by increasing the primary winding of the ignition coil, but that would cause more power (heat) to be dissipated in the coil and reduce its life. This rambling may seem to lead to nowhere but explaining why cars have a ballast resistor, but there is an ignition bonus hidden in all this. Back in the low tension discussion, the time required for the coil to store a full charge of energy in the magnetic field was discussed. Also discussed was how this related to dwell time and dwell angles at maximum engine speed. It turns out that effectively doubling the coils resistance without changing the inductance or number of turns of wire, cuts the recharge time in half. Half the recharge time means the engine can run twice as fast and still have a full power spark. This is important for those of you interested in building high speed engines and it is so simple.

Transistors are needed for any further improvements. Transistors are simple devices now made of silicon (sand) and a few thousand metal atoms. They are actually current multipliers. If you put 0.1 amp into the base (control input pin), that will cause 1.5 amps to flow into the collector (output pin). Some transistors are very linear and make good amplifiers and others are optimized to be on or off and called switching transistors. For ignition circuits we are interested in power transistors that can switch the maximum current that will flow in the coil and can withstand the voltage pulse needed for the actual spark.

The most robust transistors today are silicon NPN and they need current put into the base to turn them on. Points from the conventional ignition close and provide a ground signal when the coil is to be on. A second transistor, PNP (2N3905), is added that can be turned on by a signal that goes to ground, like the points signal, and this second transistor can provide the current to turn on the main NPN transistor. The power NPN transistor is used like the switch or the points in the conventional circuit. The transistor is not as good of a switch as the points are, it has a small voltage drop across it, about .3 volts. This is a loss but it is small in the big ignition picture.



So this is great we have added 2 transistors and a resistors and it sounds like it works the same. The transistor is a current amplifier and we are using two of them. In conventional ignition the full coil current, about 6 amps flows through the points. In this circuit the 6 amps flows through the transistor but only 0.025 amps is required through the points. This lower current at the points makes them more tolerant of a little oil or oxidation and makes the ignition more reliable. The transistor has no moving parts and there is nothing to contaminate so this will be a more reliable switch.

That increase in reliability would be enough to switch but just like any infomercial product “but wait there’s more”. Transistors do not store energy, they and the coil driver circuit above is basicly a resistor load. Back in the discussion about low tension ignition, we discussed resistive loads, they change current instantaneously, and don’t arc at the contacts especially at very low currents like we now have. We no longer need a capacitor across the points as we did in conventional high voltage ignition. Some of you have probably leaped ahead and are waiting for the capacitor to be moved so it is across the transistor which is now the switch. Transistors are solid state switches, have no moving contacts, and have no place for an arc to form. As far as we are concerned here, they just turn off. The voltage can surge up to the rating of the transistor. Back in the high voltage ignition discussion, the capacitor prevented the points from arcing as they open, but the capacitor also reduced the peak amplitude of the ignition pulse. Without the capacitor, the transistor circuit ahs about twice the peak potential ignition voltage as did the original conventional ignition circuit. The energy is still the same, the spark duration is nearly identical but there is all this extra voltage available.

Basic transistor ignition may be a little confusing, it is simple, allows faster engine speeds, and produces more potential voltage for a spark, it is the way to go.

Next time I will continue with more about transistor ignition and Hall sensors.