Perhaps More Than You Wanted To Know About The Model T Ford Ignition System

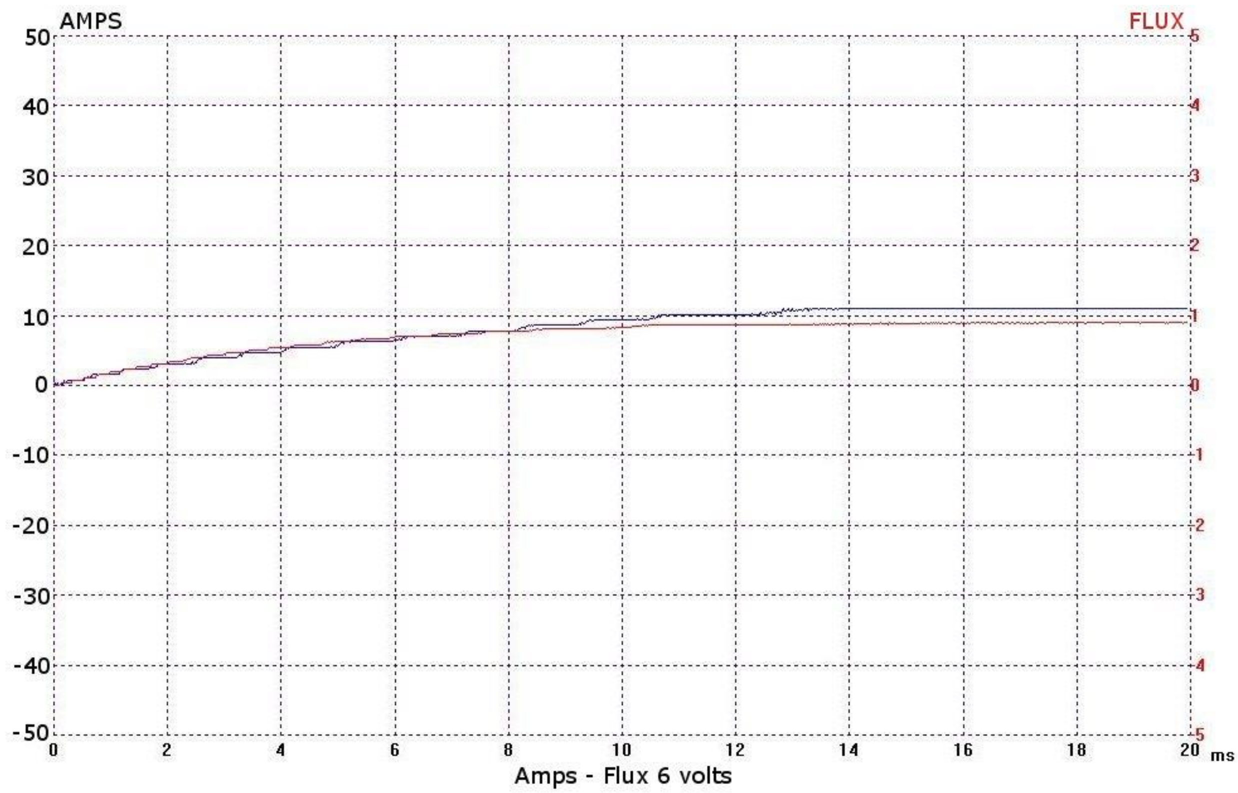
By Tom Carnegie

Introduction:

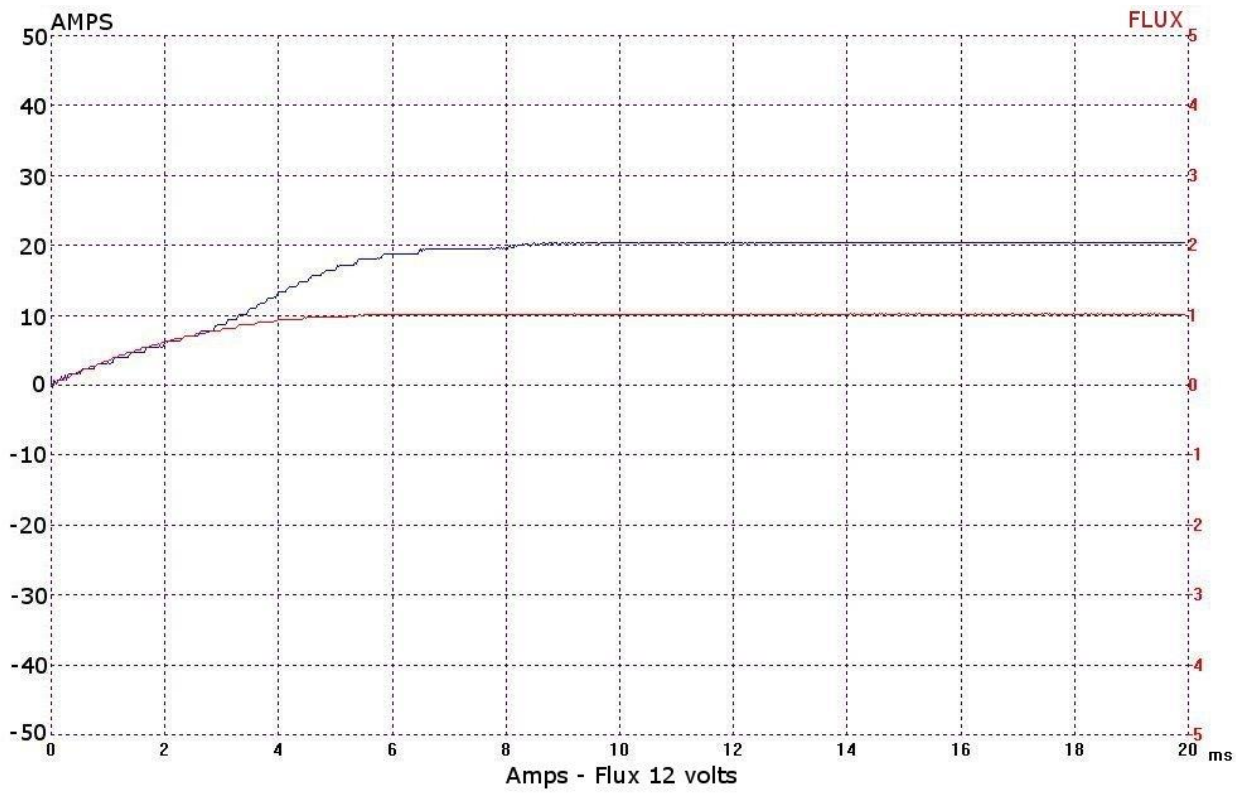
Most of my readers should be fairly familiar with the operation of the model T Ford ignition system. The purpose of this article is to give an in-depth look at the system - not to draw any conclusions necessarily, but rather to just show what is going on. I will show some oscilloscope traces of what I've observed. I will try not to be "technical", but because of the nature of the situation some "technicality" is inevitable. I will not spend a lot of time defining terms, as that would make this article much longer than I want it to be.

DC operation:

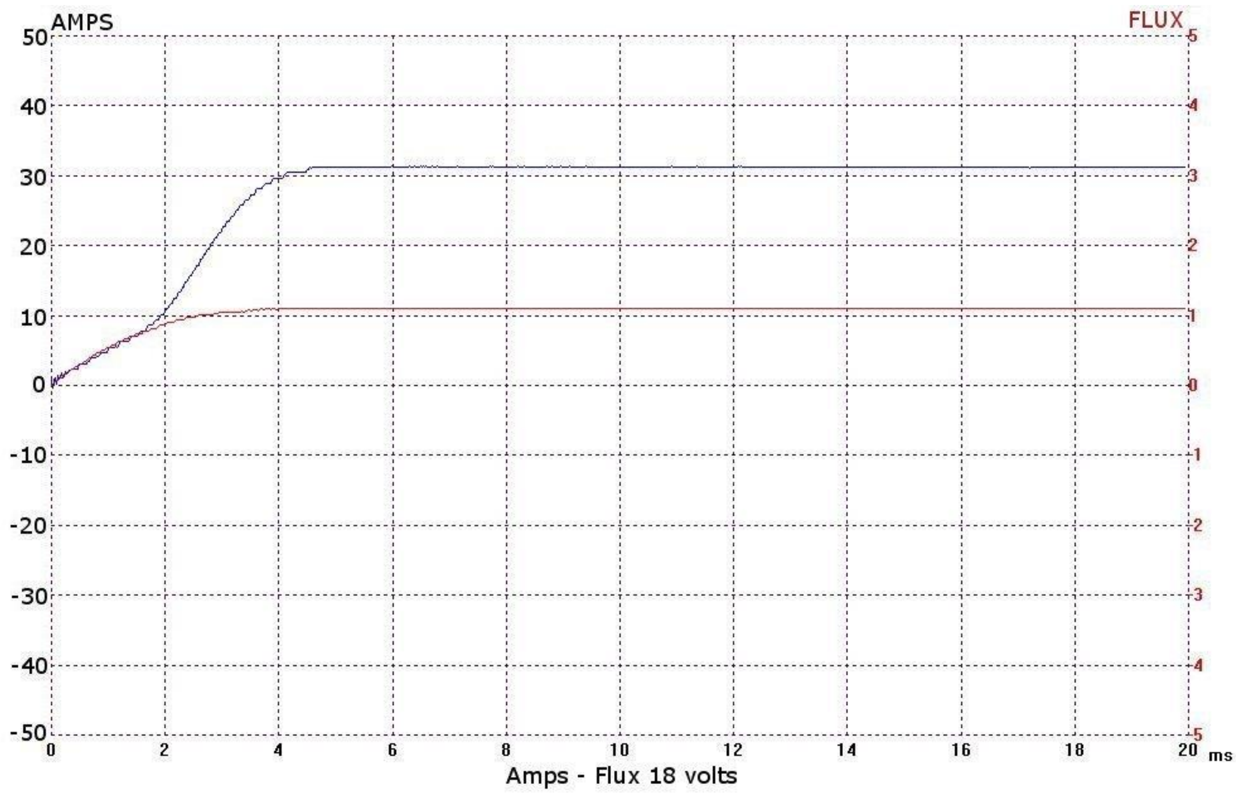
Most of the time the stock model T runs on "mag". The "mag" produces a form of alternating current. The reaction of the coil on DC is somewhat different from that of AC, but is perhaps easier to understand so it will be the starting point of this article. The primary circuit of the model T ignition coil is an inductor. Induction is momentum of electrons and forcing electricity through a coiled up wire increases induction. Putting an iron core in the center of a coil of wire further increases the induction. When voltage is applied to the primary circuit of a coil the current begins to build. As it builds it is overcoming the inertia of the inductive circuit. At some point in time the circuit will reach equilibrium, that is the current will rise to a certain point then become stable. The point to which the current will rise is a function of how much voltage is applied to the inductor. Current flowing in an inductive circuit is a form of kinetic energy. While current is flowing in an inductor it is stored as magnetism. The amount of magnetism, or "flux" in an inductor is proportional to the current of the circuit, unless the inductor core has reached saturation. I will talk about core saturation more later. Let's take a look at what happens when voltage is applied to a T coil. We will start with six volts.



The top line shows the current and the bottom line shows the flux. The flux follows the current closely. By 14 ms they are both fairly stable with the current maxing out at around 10 amps. On this graph the flux scale doesn't necessarily correspond to any specific unit, we'll just call them units of flux. The graph shows about one unit. Now let's see what happens as we increase the current in the circuit. The current is a function of voltage, so increasing the voltage will increase the current proportionally. Here is a graph with twelve volts applied.



The flux rises with the current, then levels off. This is because the core of the inductor has become saturated. Any current above the amount needed to saturate the coil is wasted as heat. Although the current doubled to 20 amps, the flux is about the same as with six volts. It looks like the core is almost, but not quit saturated with the current from 6 volts. Now let's look at eighteen volts.



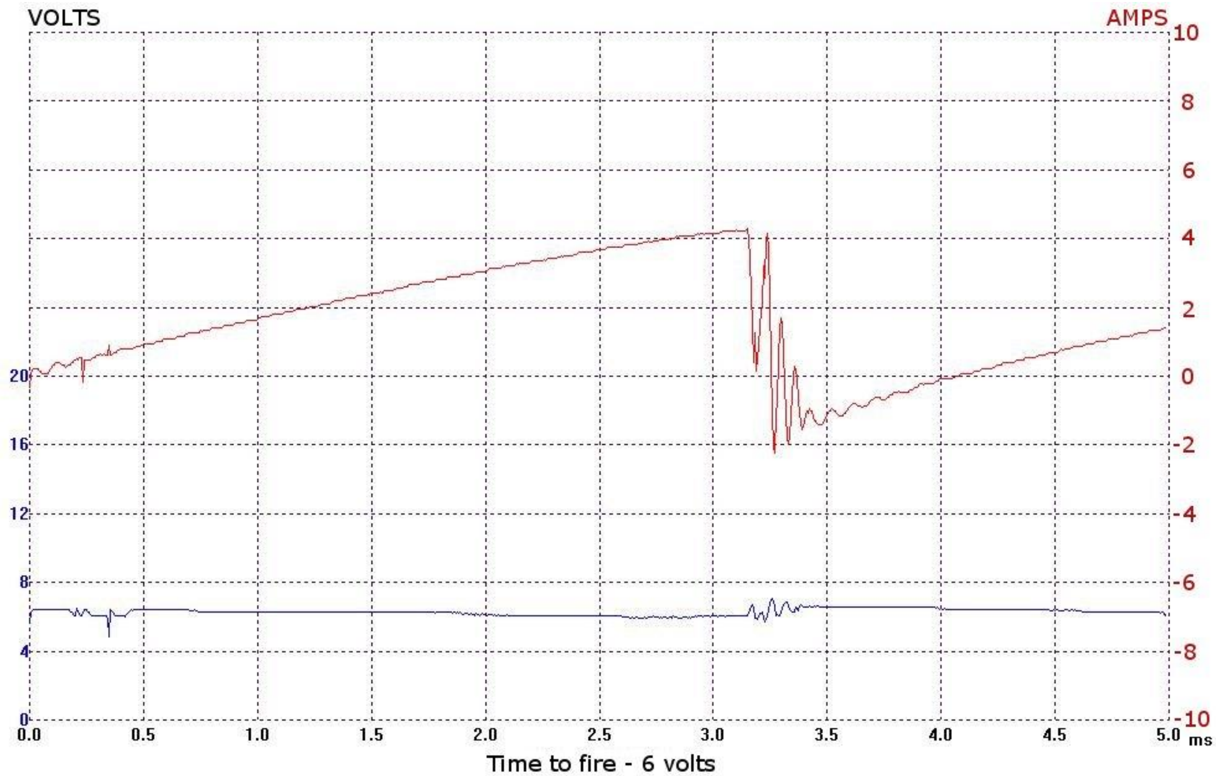
The current is about 30 amps, but the flux peaks at pretty much the same value as with 12 volts. Notice that with 12 volts it took about 6ms to achieve saturation but with 18 volts it only took about 4ms.

How much is enough?

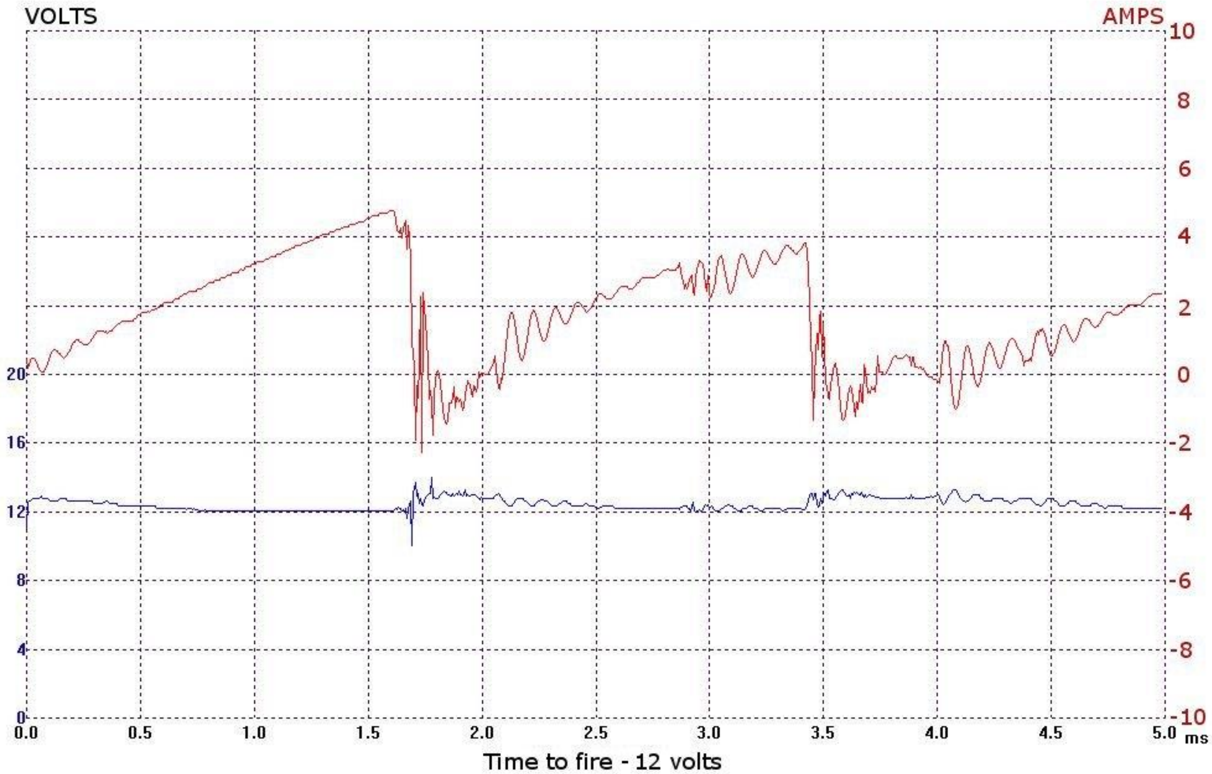
With a variable resistor as a current limiter I can adjust the amount of current flowing through the coil in real time. I can watch as the flux and current rise together until the coil is saturated, then the current continues to rise, but the flux does not. The strength of the magnetic field is proportional to the flux. So, how much flux is needed to open the points on a properly set up coil? Most people set their coils up to draw 1.3 amps on a hand-cranked coil tester. The amp value that is indicated on a hand-cranked coil tester is the average current. Since the points are open some of the time the average value is lower than the minimum value required to open the points. I took several such coils and with a variable resistor in the circuit adjusted the current until the points just opened on each. The coils varied somewhat, but on average the current needed to open the points was 2.8 amps.

How long does it take?

If operating on battery, it seems that the points would open about the time the coil amperage ramped up to 2.8 amps. In fact, the coil will ramp a little higher than this because it takes a little extra time due to inertia and the upper contact point drop. On 12 volts it will ramp a little higher than on 6 volts. The graph below shows time to fire of a typical coil on 6 volts.



The top line is current and the bottom line is voltage. The current ramps up to about 4 amps and it takes about 3.2 ms to fire. Below is a graph of 12 volts.



The current ramps up to about 5 amps and it takes about 1.7 ms to fire. One ms is 12 degrees of crankshaft rotation at 2000 rpm. Depending on tire size and such 2000 rpm is about 50 mph. The time-to-fire is affected by a lot of different factors besides circuit current. Some additional factors are point tension, upper point drop, point gap and coil construction.

Ain't it amazin'?

I've had discussions with folks who say something to the effect "isn't it amazing what the old time engineers could do without benefit of our modern equipment". Well, yes it is. Those fellows were very smart and clever back then, but they weren't flying as blind as you might think. They had excellent methods of graphing waveforms using mechanical means. They also had devices capable of giving real time visual images as early as 1892. The cathode ray tube was invented in 1897. Below is an image from the book The Alternating Current Transformer in Theory and Practice written in 1890 and published in 1892 by John Ambrose Fleming. This is essentially the same graph as the current portion of the first graph presented in this article.

the diaphragm, and assuming that the telephone diaphragm vibrates in extent and manner so as to imitate exactly the changes of current strength in its coils, we get an optical reproduction of the form of the periodic current sent through

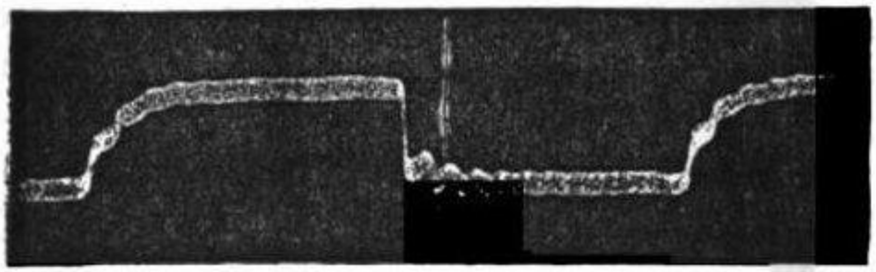


FIG. 25.

the telephone. If, for instance, a constant E.M.F. from a battery is applied through an inductive resistance, and then removed, we get the current curve, shown in Fig. 25, repro-

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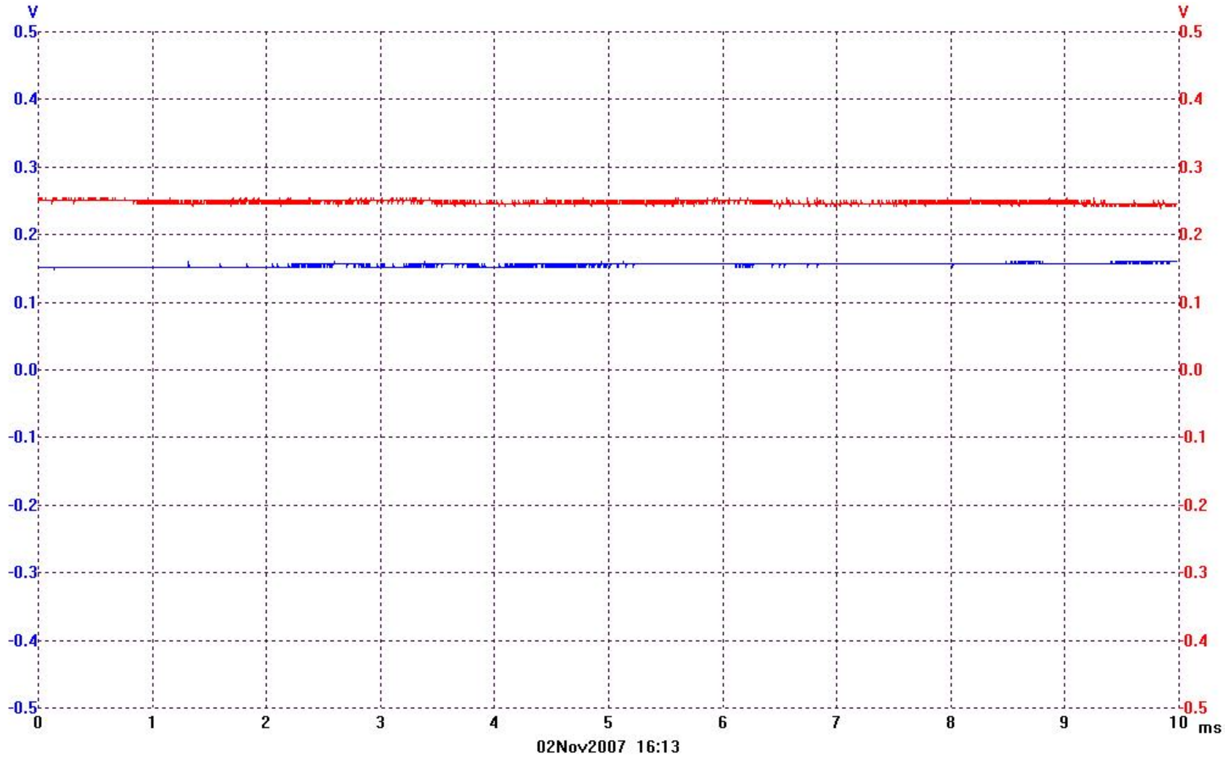
Next up

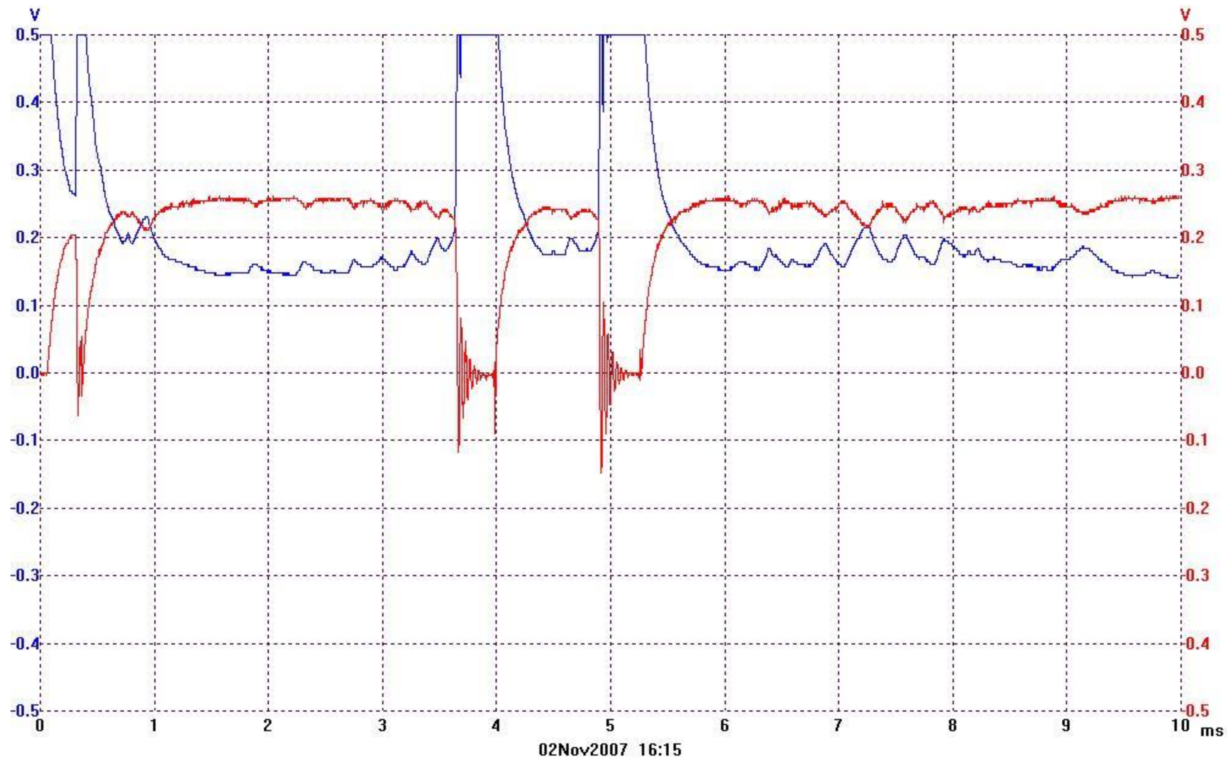
Next we'll discuss the coil operation on mag. The magneto produces alternating current and the operation of a coil on alternating current is a whole different ballgame.

end of article

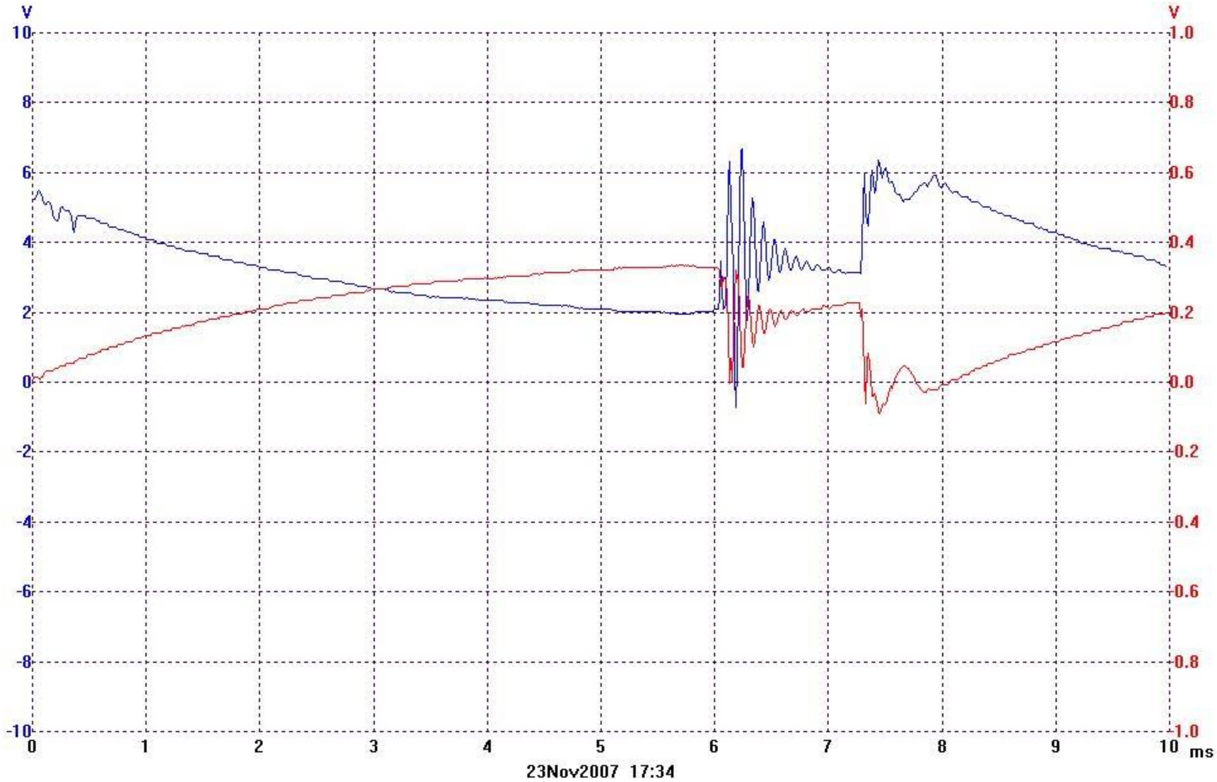
The following are graphs that are not part of the article but are presented here because they may be interesting.



The above graph shows the operation of the coil through a current limiter. I adjusted the current to the maximum value that would not fire the coil. The blue scale on this and the graphs below is volts/10. The red scale is amps/10.



The above graph shows the coil through a current limiter right at the firing current. It is a real time capture as the coil was blithely buzzing away.



The graph above is a single shot of the coil through a current limiter at just above minimum firing current.