A New Approach to Coil Point Adjustment

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As a new Model T owner, I have been studying the performance of the original ignition system and how to make it perform optimally. My original intent was to see how various timers and ignition systems compared. My findings were rather surprising and have led to what may very well become a new standard for coil adjustment for the stock ignition system. This article explains the new approach and how it all happened.

The first step in my study was to obtain properly rebuilt and adjusted sets of coils from at least 3 well known and respected coil rebuilders. I characterized each coil to see what its operating characteristics were before conducting any further ignition performance testing. Coils were characterized with the test set up illustrated in figure 1.

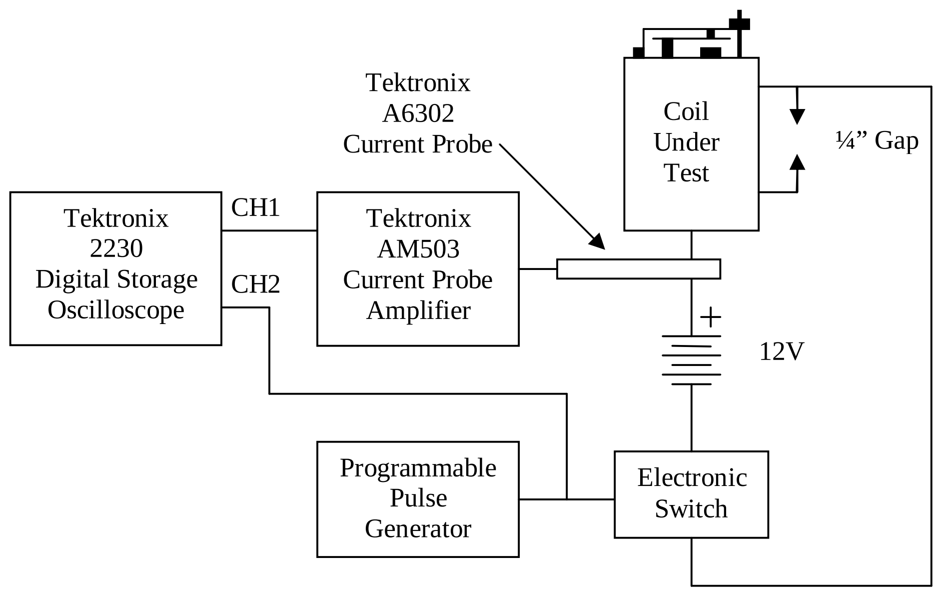


Figure 1 Coil Characterization Test Set Up

The electronic switch functions as an ideal Timer commanding the coil to spark without any variation or bounce associated with the roller, brush or flapper of a standard Timer. The Programmable Pulse Generator functions to activate the electronic switch (Ideal Timer) like when the CAM is in the firing position. The current probe monitors the coil current and the storage oscilloscope provides a visual measurement of the coil current as a function of time that can be captured for further study. The coil current is monitored continuously the entire time the coil is charging (Dwell) and firing. Not just average or RMS value as read by ammeter. Characterization was done with both 6V and 12V.

The test set was calibrated using a 2.5 Ohm power resistor to verify a 12/2.5 = 4.8A current was measured while operating on 12VDC. All coils were then characterized in the same test fixture with ¼" spark gap using a 4ms square pulse.

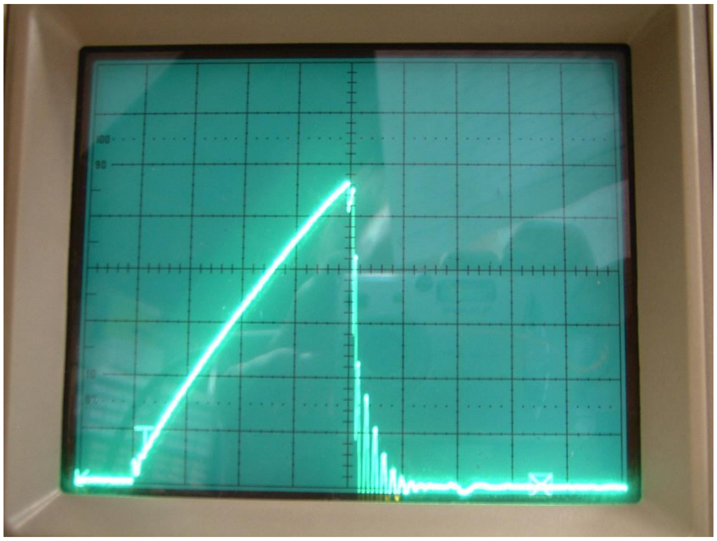
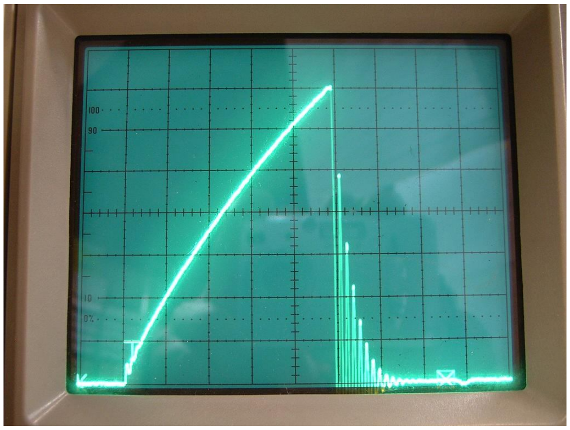


Figure 2 – Coil Current and Firing Time

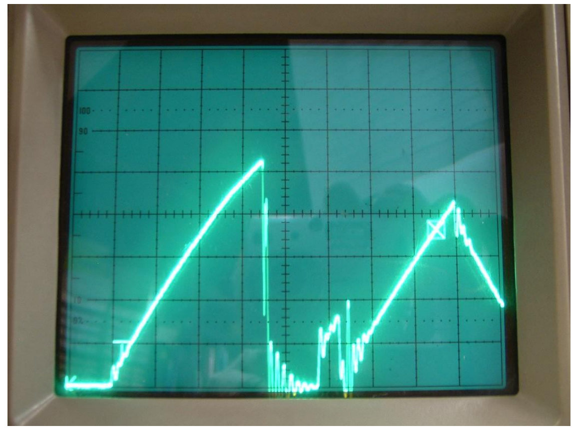
Figure 2 illustrates the expected measurement observed on the oscilloscope. For those not familiar with an oscilloscope, it is an instrument which allows you to view voltage or current as a function of time. Each horizontal division is 0.5 ms (0.0005 second), each vertical division is 1 Ampere (A) with bottom line the 0A reference. The coil is at rest so this represents the first spark responsible for combustion. The coil is commanded to spark at time 0.5ms after the trace starts from the left side of the screen. The coil fires its spark 2ms later (4 div x 0.5ms per div) so the coil dwell time is 2ms. The coil current at the time of firing is 5.7A (5.7 div high x 1A per div) then drops to zero generating the high voltage spark. The series of current spikes is actually a damped oscillation of current interacting between primary and secondary windings as the spark occurs. The peak coil current at the time of firing is very important because it determines the spark energy (AKA how hot the spark is). The longer the dwell time, the higher the current and the hotter the spark. The consequence of longer dwell time, however, a more retarded spark since the engine is turning while the coil is charging. The widely accepted method of coil point adjustment utilizes a Hand Cranked Coil Tester which utilizes the RMS current to set the points. The RMS current is a way of measuring a time varying current so that it is equivalent to a DC (Direct Current – one that does not vary with time). The problem is that it is just an indicator of proper operation. Many different time varying coil currents can produce the exact same RMS current reading on the HCCT ammeter including the dreaded "double spark" where two weak sparks occur in the same time as the desired spark. The HCCT has the advantage over a simple "Buzz box" coil tester relying solely on coil current because it permits the operator to observe the spark produced by the coil as a function of time as they turn the crank; kind of like a crude oscilloscope. Double sparking can thus be observed and corrected even though the RMS ammeter produces nearly the same reading in the absence of double sparking.

The following is the coil characterization data I took on coils properly adjusted by professional coil rebuilders using commonly accepted best practices and experience.

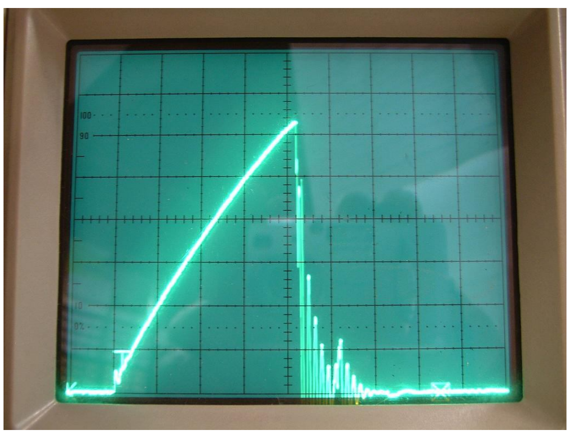
Scale: Vertical: 1A/div, Horizontal: 0.5ms/div



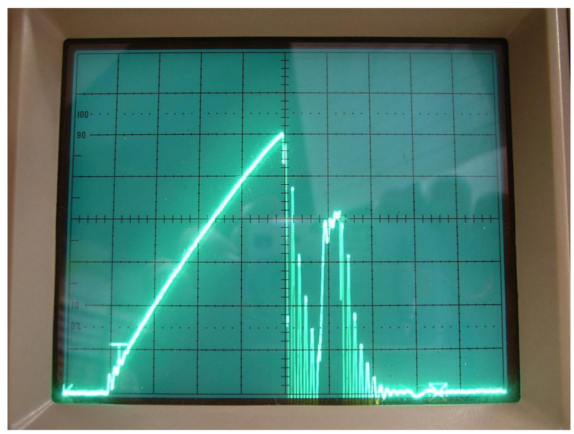
Vendor 1 Coil 1



Vendor 1 Coil 2



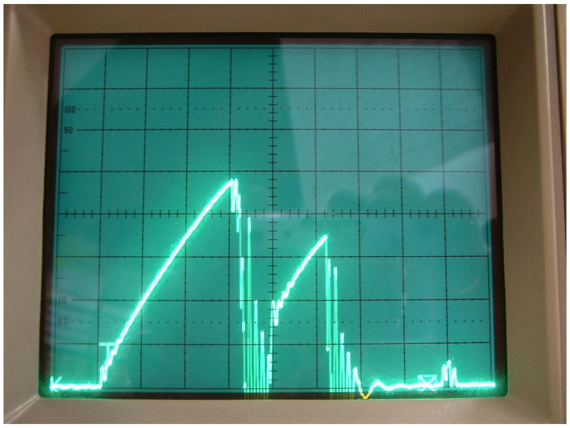
Vendor 1 Coil 3



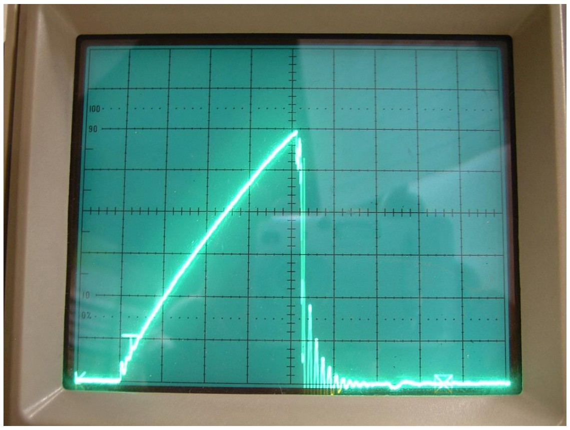
Vendor 1 Coil 4

Vendor 1 Coil 2 exhibited classic characteristics of double sparking – two weaker sparks separated in time; yielding similar RMS current on an analog meter. This was unexpected. Coil 4 had almost normal firing current but did have indications of a second spark which would add to the RMS current on the ammeter. Most notable was the differing coil dwell times which causes ignition timing variation.

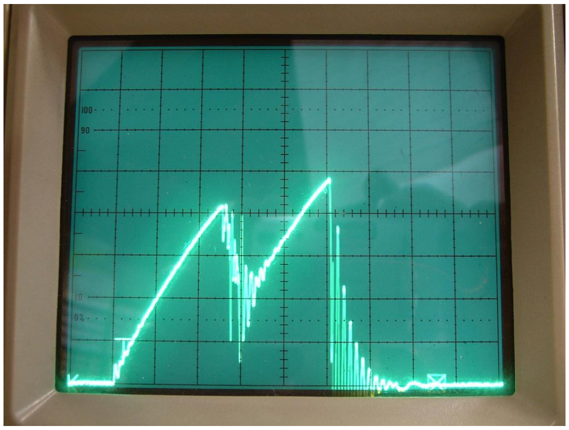
Scale: Vertical: 1A/div, Horizontal: 0.5ms/div



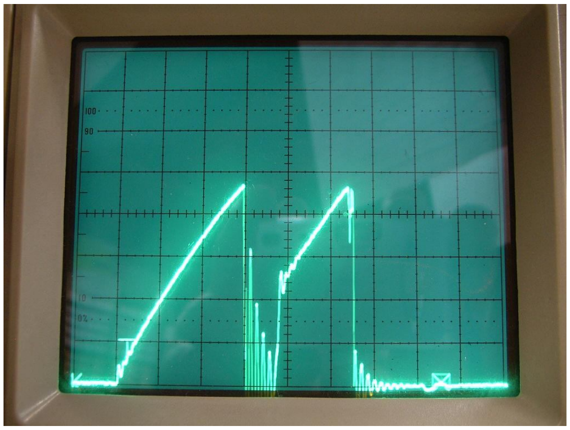
Vendor 2 Coil 1



Vendor 2 Coil2



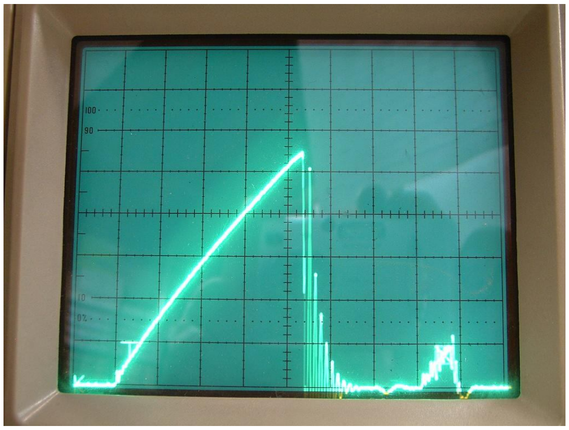
Vendor 2 Coil 3



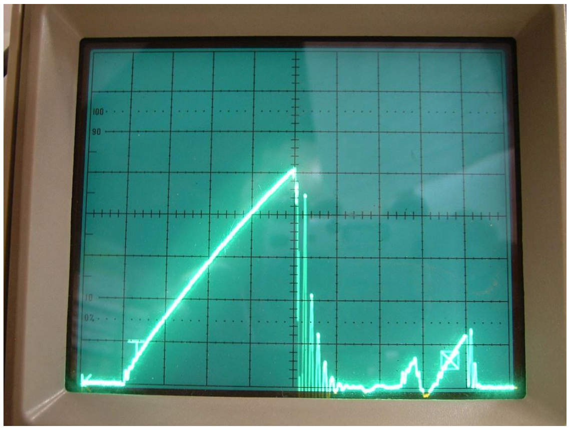
Vendor 2 Coil 4

Vendor 2 Coils 1, 3 and 4 also exhibited classic characteristics of double sparking – two weaker sparks separated in time; yielding similar RMS current on an analog meter. This too was unexpected and very surprising. Again, significant coil dwell time was observed leading to ignition timing variation.

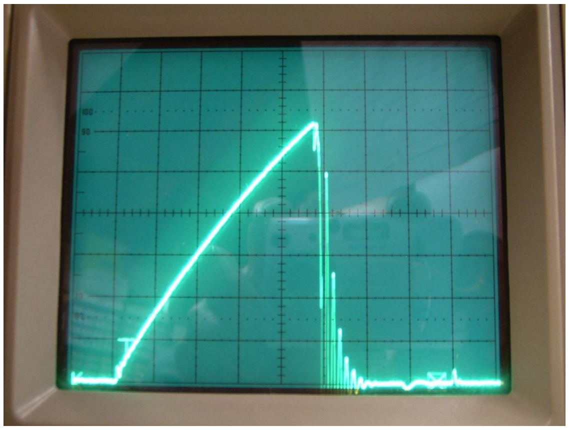
Scale: Vertical: 1A/div, Horizontal: 0.5ms/div



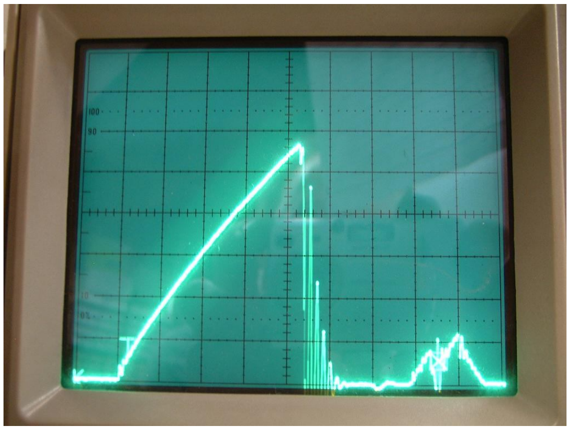
Vendor 3 Coil 1



Vendor 3 Coil 2



Vendor 3 Coil 3



Vendor 3 Coil 4

Vendor 3 Coils showed no signs of double sparking but significant coil dwell time variation was still apparent which will lead to ignition timing variation.

A summary of the coil test data measured on the oscilloscope is presented in tabulated form in tables 1, 2 and 3. The abbreviation DS is used to indicate “Double Sparking” was observed.

Vendor 1

Coil	Firing Current (A)	Firing Time (ms)	
1	7.05	2.49	
2	5.25	1.8	DS
3	6.35	2.1	
4	6	2.05	DS
Average	6.1625	2.11	
Max	7.05	2.49	
Min	5.25	1.8	
Delta	1.8	0.69	ms
Delta		4.14	Deg/1K RPM

Table 1 Vendor 1

Vendor 2

Coil	Firing Current (A)	Firing Time (ms)	
1	4.8	1.6	DS
2	5.9	2.15	
3	4.2	1.5	DS
4	4.7	1.5	DS
Average	4.9	1.6875	
Max	5.9	2.15	
Min	4.2	1.5	
Delta	1.7	0.65	ms
Delta		3.9	Deg/1K RPM

Table 2 Vendor 2

Vendor 3

Coil	Firing Current (A)	Firing Time (ms)	
1	5.5	2.7	
2	5.1	2.05	
3	6.2	2.4	
4	5.65	2.2	
Average	5.6125	2.3375	
Max	6.2	2.7	
Min	5.1	2.05	
Delta	1.1	0.65	ms
Delta		3.9	Deg/1K RPM

Table 3 Vendor 3

Note that the coil firing current measured by the oscilloscope is the value of current flowing in the coil primary winding at the instant of firing and not just the RMS current measured and displayed on an ammeter. This is an important distinction because the RMS current reading can be influenced by many variations including the presence of double sparking. Coil dwell time was also measured and recorded in milliseconds (1ms = 0.001s) as well as timing variation in engine crank shaft degrees assuming 1,000 RPM operation. The data clearly indicates coil performance is not optimally set in all instances. This was obviously not apparent to the experienced operators when the coils were adjusted using best tools currently available.

Superior engine performance could be achieved if each coil were adjusted for the same firing time rather than the same time averaged RMS current as is done with the Hand Cranked Coil Tester (HCCT). The coil current can actually be within a reasonably broad range and still ensure sufficient spark energy to produce a good hot spark, however, by adjusting coils for the exact same firing time helps minimize cylinder to cylinder ignition timing variation attributed to the coil. The problem is; not everyone has access to precision test equipment and the knowledge to properly use it. Those that do, I believe, have a substantial advantage over those that don’t for competition sensitive events like hill climbs or the Montana 500.

Fortunately, modern electronics makes precision time and current measurements possible and simple to use once properly programmed to perform a desired task such as the one just described. All that is necessary is a way to sample the coil current and display the time and current when a spark is produced. The real challenge is to create a way to it affordably. Figure 3 illustrates such an instrument currently under development capable of measuring coil firing time and current. It uses a current probe (red card) in inserted into the coil box; breaking connection between the timer and coil primary winding to sample coil current when the timer is in firing position.

Coil firing time and current are accurately displayed with the push of a button hence the instrument is referred to as an Electrically Cranked Coil Tester (ECCT). The ECCT permits testing and adjustment of the coils in their target installation with all contact resistance and wiring variables included in its measurement. This includes coil box contacts as well as timer and roller/brush/flapper contacts. Each coil points can be adjusted as necessary for the same firing time and optimal engine performance.

Figure 3 – The Electrically Cranked Coil Tester (ECCT) Prototype

In summary, a new method of coil point adjustment was presented using coil firing time as opposed to time averaged RMS current. Simplified adjustment and superior engine performance are potential benefits of the new method. The ECCT is an instrument under development that will make the new method accessible. Folks interested in following the development of the ECCT are invited to visit the website at www.modeltecct.com

<u>About the Author</u>

Mike Kossor, WA2EBY holds a Master's Degree in Electrical Engineering and has over 30 years of experience designing innovative solutions to complex electrical problems ranging from highly linear microwave power amplifiers to the E-Timer electronic ignition. Mike holds an Extra Class amateur radio license and drives a 1927 Touring. He can be reached at: mictel@comcast.net