The Model T ECCT

Coil Adjustment May be Getting a Whole Lot Easier and Much More Accurate

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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 it compared with the E-Timer Electronic Timer. 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.

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.

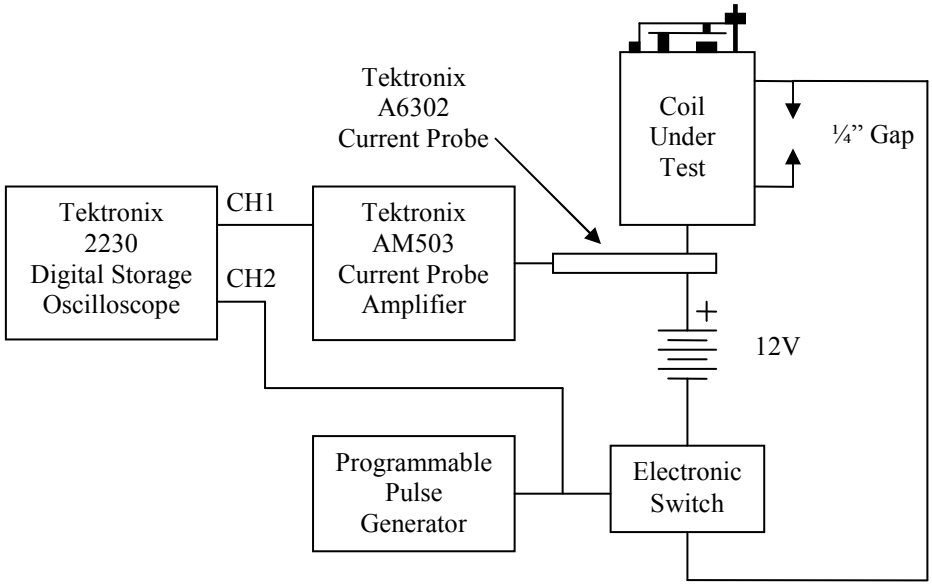


Figure 1 Coil Characterization Test Set Up

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 amp meters. 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.

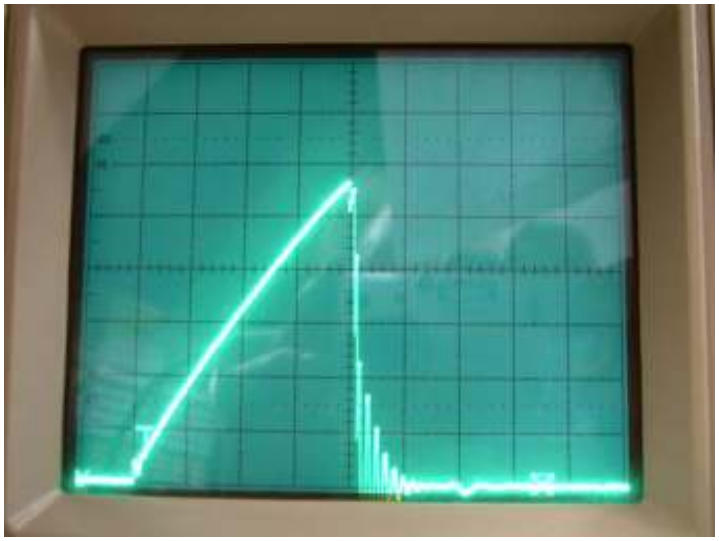
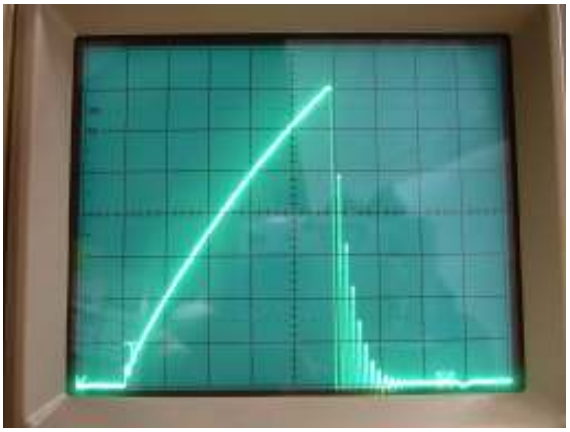


Figure 2 – Coil Current and Firing Time

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 amp meter 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 amp meter produces nearly the same reading in the absence of double sparking.

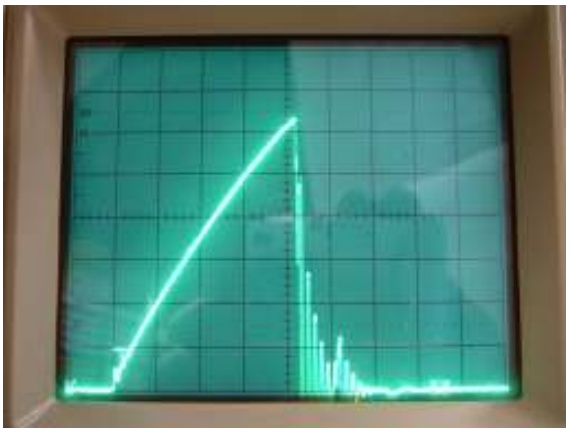
The following is the coil characterization data I took on coils properly adjusted by professional coil rebuilders using commonly accepted best practices and experience.

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

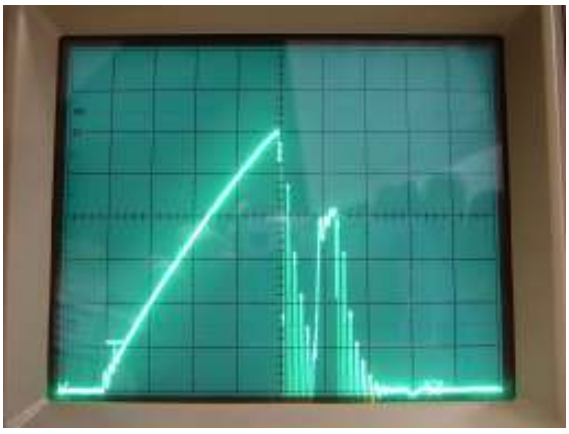


Vendor 1 Coil 1

Vendor 1 Coil 2



Vendor 1 Coil 3

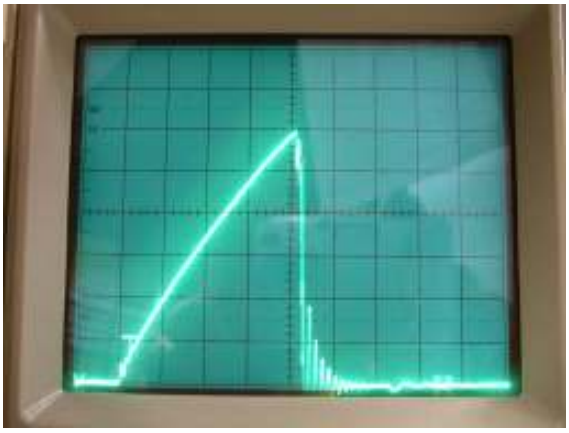


Vendor 1 Coil 4

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 amp meter. 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



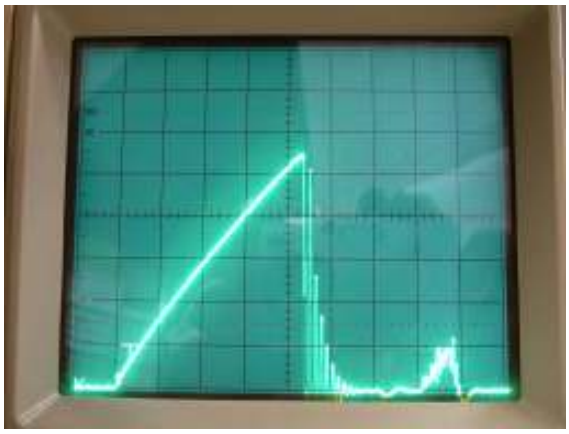
Vendor 2 Coil2

Vendor 2 Coil 3

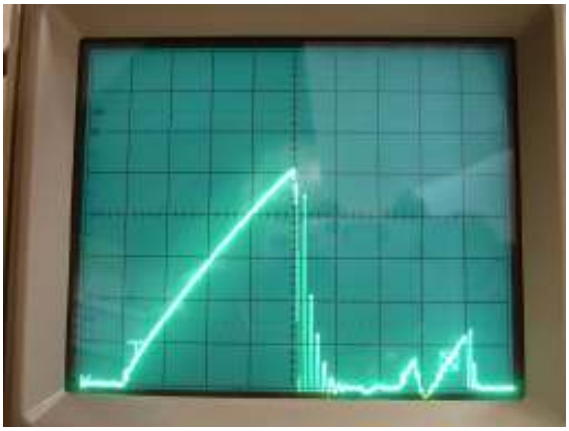
Vendor 2 Coil 4

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.

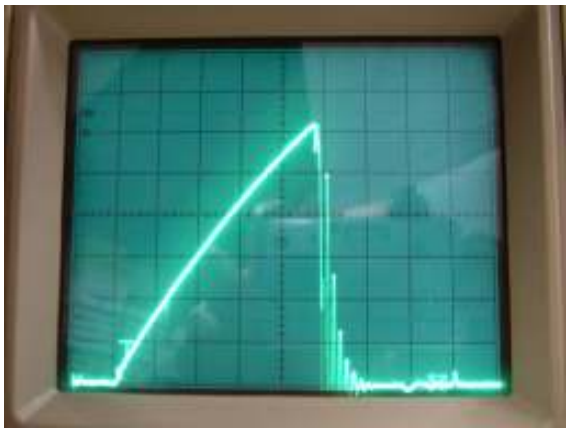
Scale: Vertical: 1A/div, Horizontal: 0.5ms/div



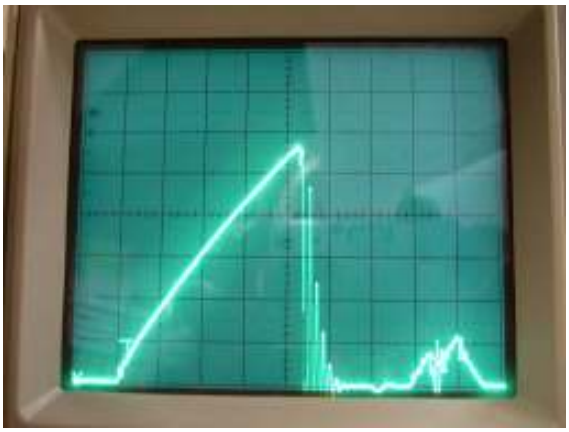
Vendor 3 Coil 1



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.

Here is a summary of coil test data measured on the oscilloscope in tabulated form.

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

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

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

Note that the coil firing current is measured at the instant of coil firing and not just the RMS current as displayed on an amp meter. Coil dwell time was also recorded and displayed in ms as well as timing variation in engine crank shaft degrees assuming 1,000 RPM operation. The data clearly indicates coil performance may not be set optimally in many instances. This obviously was not the case when adjusted with the best tools available by experienced operators. It would be great if coils could be adjusted based on the ideal step response as I had done. Not by firing current alone but also by firing time. The firing current can be within a reasonably broad range and still ensure sufficient spark energy to produce a good hot spark, however, by monitoring the actual firing time, optimal point adjustment could minimize ignition timing variation attributed to the coil. The problem is; not everyone has access to precision test equipment or the knowledge of how 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 the Montana 500. This got me thinking about how the same technology responsible for the E-Timer's exceptional performance could be applied to development of a precision instrument capable of measuring stock coil performance and used as a tool to optimally adjust coil points easier and more accurate than ever before.

The Electrically Cranked Coil Tester (ECCT) is what evolved, illustrated in Figure 3.

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

The ECCT is a light weight (7 oz) portable instrument which permits testing and adjustment of the coil in its 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. The car is cranked with the ignition off until the desired cylinder timer contact is in firing position. A thin probe is inserted into the coil box to break the timer connection and allow the ECCT to assume firing control. The ignition is turned on to begin coil testing under ECCT control.

The first test is to check the battery voltage and capacitor (condenser) while the coil points are held open. The ECCT checks for the proper capacitance value (0.47uF). Off value as well as open, short and leaky capacitors are clearly indicated by a red FAIL indicator.

Coil test mode is selected next and the test button is pressed. The ECCT computer monitors the coil charging current and time until the coil fires just like on the storage oscilloscope. The data is checked for the proper firing current and firing (dwell) time. The green PASS indicator is illuminated when both these values are within acceptable

ranges. The Firing time is indicated in degrees relative to a nominal value at 1,000 RPM. Each coil can be finely tuned in car to fire to within 1 degree of each other. The firing current is a secondary consideration. A double sparking event is always caught by the computer and indicated by illuminating 2 timing error LEDs in the display.
Lastly, the Multi-Spark coil test mode is selected. The ECCT fires a sequence of 100 first sparks at the equivalent rate to 2,000 RPM. Each firing is evaluated and binned within the firing current and firing time range. The variation in firing current and firing times is displayed to the operator when the test is complete. Only current and time bins that fired more than 5 times are displayed to get a sense of the majority of firings. A good set of points, properly adjusted will yield minimal variation in firing time, typically 1 degree at 2,000 RPM. Points that are warn, dirty or sticking will yield a wider range of current and timing error in the Multi-Spark test. Early non-battery equipped cars can still be tested by temporarily connecting a 6V or 12V battery by disconnecting the magneto wire from the mag post and connecting to the battery.

A dedicated ECCT Test Fixture has been designed and built to permit coils to be tested on the bench using a suitable 6V or 12V battery or power supply. Serious coil rebuilders and racing enthusiasts may be interested to learn a computer interface to the ECCT is under development which permits highly accurate coil current and dwell times for precise adjustment and statistical analysis of coil operation. The ECCT Coil Test Fixture is shown in figure 4.

Figure 4 – ECCT, Coil Probe, Coil Test Fixture and Power Supply

A lot of effort went into making the ECCT modular. The basic coil probe utilizes the existing car battery as power source and existing coil box as test fixture. This helps keep the initial cost of the basic ECCT low. The coil test fixture, power supply and computer interface can be added later, if desired, for expanded capability. The project is still in the development phase and will soon be entering the Beta test phase whereby experienced and non-experienced coil rebuilders will be using the ECCT to test and adjust coils. Road test performance reports will be collected to determine the effectiveness of the ECCT. Folks interested in the ECCT can see the proto type at the **Hershey 2012 swap meet October 10, 11, and 12** at the E-Timer space in the **Red field: RCC-33**. Questions and comments may be directed to mictel@comcast.net.

The E-Timer was a welcome option and revered by many users but it unintentionally created a divide among the hobby because it utilized modern electronics to displace stock components; despite the fact there are no modifications to the car or wiring, everything appears original and coil points still vibrate and buzz. The ECCT again utilizes modern technology to create an instrument which has the potential to simplify stock coil point adjustment with precision and accuracy previously unachievable. Its light weight, portable design will greatly simplify its use (no more hernias hopefully) and its modularity will make it far more affordable to the average hobbyist compared to an HCCT. Hopefully it will earn its place within the hobby without creating an unintentional divide.