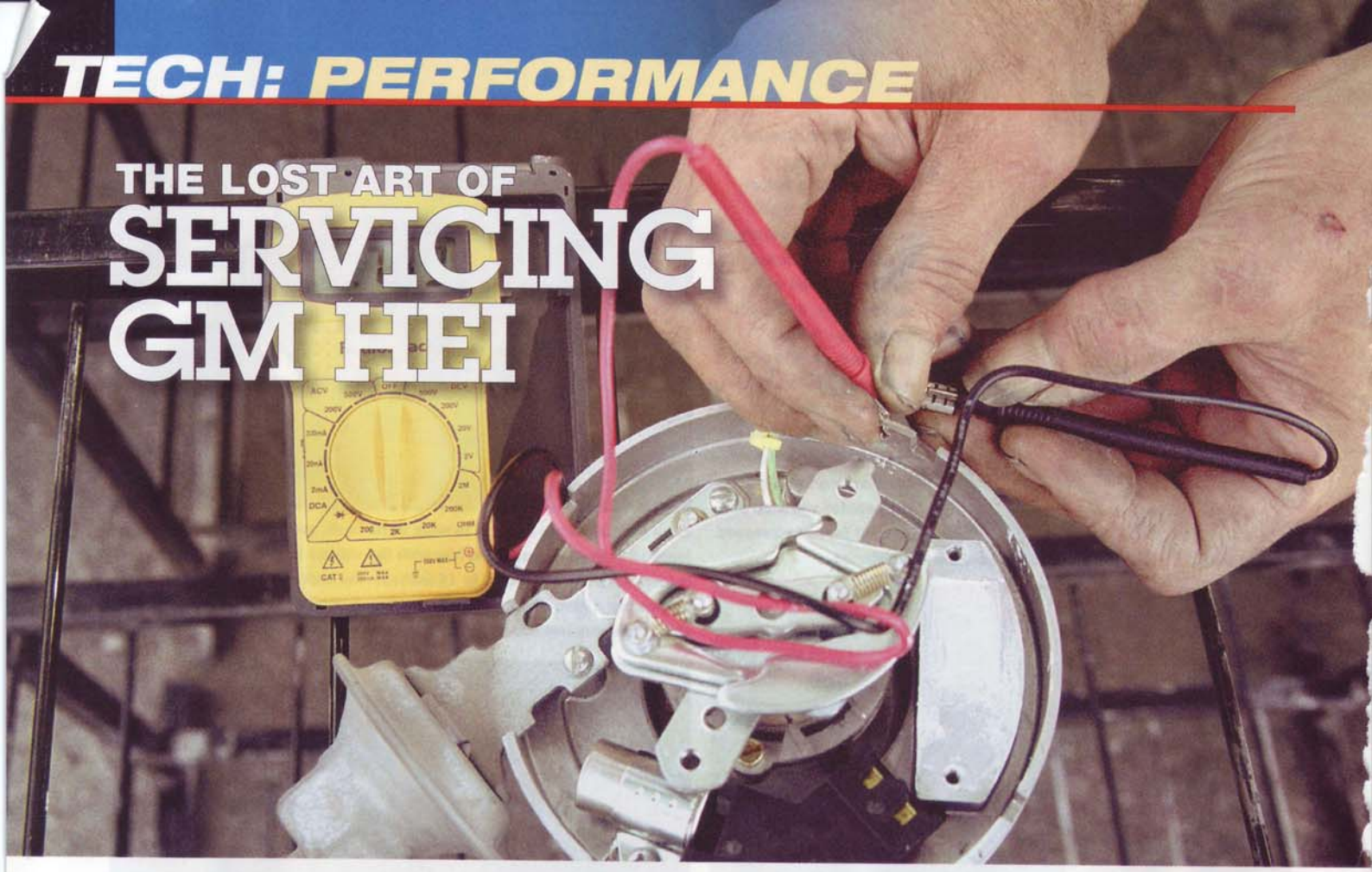
THE LOST ART OF SERVICING GM HEI



Words and Photography by Ray Bohacz

Any conversation about electronic ignition leads to the GM HEI, which is an abbreviation for high-energy ignition. Chrysler was the first company to offer electronic triggering to the masses; it was available on some models in 1972 and became standard across the board for the 1973 model year. Ford Motor Company made its Dura-Spark system standard in 1975, the same year that GM introduced HEI.

The attributes of electronic ignition, made possible by advances in transistor technology, finally answered the call to eliminate breaker points, and the undesirable features associated with them. The benefits of electronic ignition include:

- The elimination of wear parts
- High voltage and current output
- Variable dwell instead of fixed dwell (coil saturation)
- The elimination of the resistor circuit
- The ability to run widened spark plug gaps to support leaner mixtures
- Increased distributor cap secondary terminal spacing for decreased propensity for cross-firing

With the arrival of the 1973-'74 energy crisis and the federal government's new fuel economy and emissions standards, the constant degradation of ignition output with breaker points needed to be eliminated. The problem was the constant wear they suffered. As the rubbing block wore, the ignition's output would diminish; additionally, a one-degree change in dwell would impact the ignition timing a like amount, which we'll explain in detail later in the article.

Another concern was the limited voltage input that a breaker ignition could take while still maintaining an acceptable lifespan. Due to the breaker's inability to withstand a constant 12 volts, a resistance circuit was required to reduce the primary voltage to approximately 7 volts. The power was supplied through the ignition switch, arranged so that the engine would crank on full battery voltage, but when the ignition key was released to the run position, the circuit would be redirected and the voltage dropped by a resistance wire or ballast resistor. Abiding by the laws of physics, this limited the spark output potential of the coil, along with the gap of the spark plug.

The HEI difference

When Delco set out to design HEI, it addressed all of the problems with points. By eliminating the mechanical breaker system and replacing it with a transistor that had no moving parts, HEI eliminated wear problems. The additional available energy allowed for a constant output with longer spark plug life and the wider gap that was needed to remain emissions compliant.

Additionally, HEI addressed limited output. It is possible to obtain higher secondary voltage by simply increasing the current in the primary circuit: Coil energy is equal to one-half of the coil inductance multiplied by the current squared. The higher current-carrying capabilities of a transistor over breaker points automatically increased the ignition output. In most breaker point systems, the primary current was limited to 3.5 to 4.0 amperes. Maximum point life was realized with only one ampere flowing across the contacts. As current increased, point life decreased steadily until just over four amperes was reached. Above this value, point life decreased dramatically.

Transistors don't have this limitation. A switching transistor

can handle a full 12 volts with a current capacity of over five amperes. This allowed HEI to offer 40 percent more voltage output with 85 percent higher energy levels than the breaker point ignition it replaced.

For the ignition coil to produce maximum secondary voltage, the limit for primary current must be reached before the primary circuit is broken, allowing the field in the coil to collapse and discharge through the spark plug. In a points system, the length of time the primary current is turned on and charging the coil is referred to as "dwell" and is controlled by the cam in the distributor.

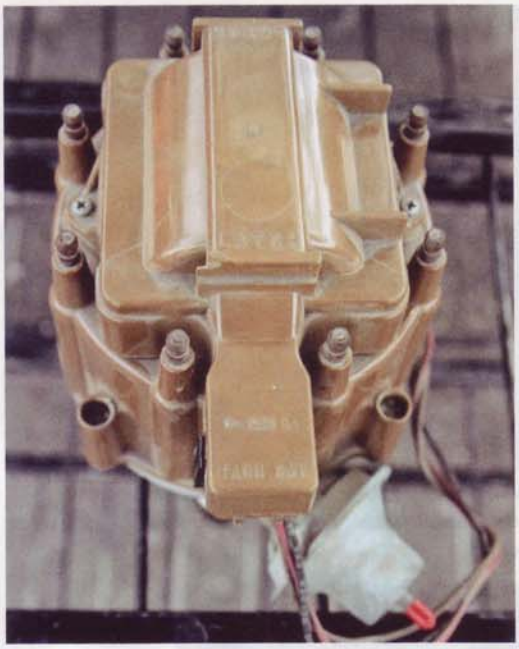
Dwell is defined as the degrees of distributor cam rotation the primary ignition circuit is turned on. Most V-8 engines using breaker points have a nominal dwell value of 30 degrees. The dwell angle remains constant regardless of engine rpm. As the speed of the engine increases, the length of physical time that the points are closed decreases. This reduces the available voltage and coil energy.

In a points ignition system, as the engine speed increases, the available energy to meet the demand of the spark plug decreases. HEI eliminated this problem by removing the resistance wire and applying full alternator output to the primary circuit.

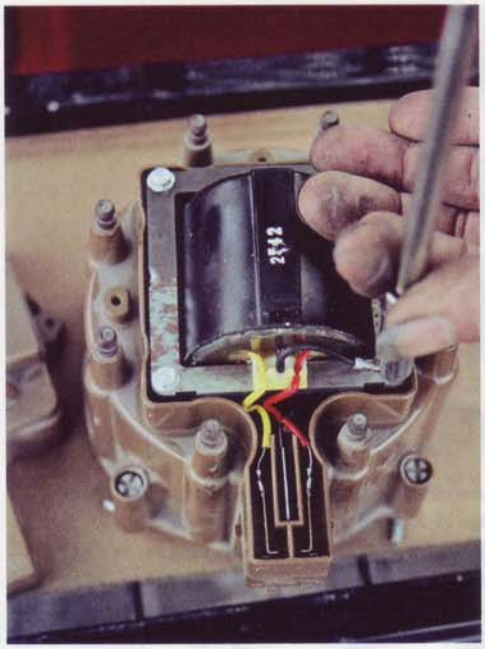
Another unique feature of HEI is a dwell period that responds to changes in engine speed. Identified as an expanding dwell, the saturation time of the coil is controlled by engine rpm. At idle, an HEI system will experience a dwell time of 10 to 15 degrees and will increase to 30 to 35 degrees by 2,500 to 3,000 rpm. The ignition now has the output when the engine needs it—at high speeds and under load.

In a points system, it would take 10 milliseconds for the current to reach maximum with a coil that has 2.6 ohms of resistance. The primary windings of an HEI coil have only 0.5-ohm resistance, allowing maximum current to be reached in approximately 3.4 milliseconds. Because it takes less time to reach full coil potential, saturation can be obtained at much higher engine speeds.

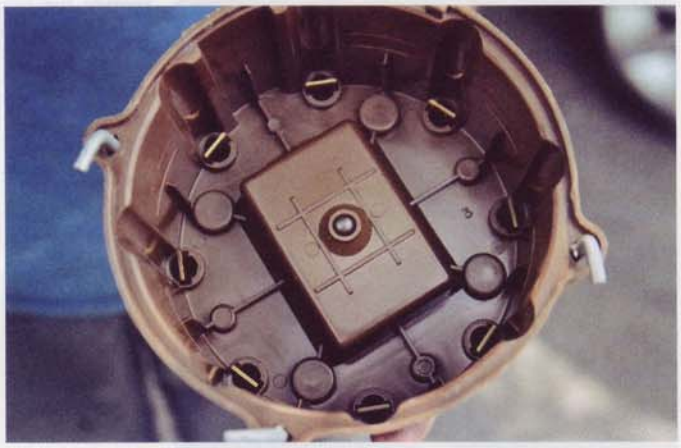
A coil can be thought of as a checking account: the more you put in, the more you can withdraw. By increasing the primary voltage input, the secondary output is increased, but more important, the length of time that the spark can burn—and the amperage at which it burns—is also increased. Electricity is passive—it uses only what it needs to get the job done. As an example, an HEI system has the ability to produce 40,000 volts to the spark plug for short periods of time. This can



The original HEI design featured an integral ignition coil and a one-wire hookup of 12 volts. The cap is marked to identify the tach and voltage supply.



The coil is retained by four screws. It is important to make sure the screws are the proper length and do not puncture the distributor cap above the rotor. The ground strap under the coil, which is used to bleed off any electrical charge that may accumulate in the coil's metal support frame, needs to be replaced.



The wide spacing of the secondary terminals in the cap was necessary to prevent cross-fire between cylinders and to eliminate arc-over to ground. This was due to the high output.

Once the coil is removed, the carbon button can be accessed. When installing a new cap, do not forget to install the new carbon button. Many leave the button out and the coil arcs to the rotor through the hole. The engine will start this way, but will misfire in a few miles.

be likened to a car that has a top speed of 150 mph. If the load on the engine only requires 6,000 volts to bridge the gap of the spark plug, that is all that is consumed. In the same manner, a 150-mph car can cruise at 65 mph, using only a small amount of its potential power.

This analogy can be modified to describe an ignition coil: It can produce low voltage for a long time period or high voltage for a short time. Instead of referencing mph, an ignition system is measured in milliseconds (ms) and degrees of crankshaft rotation (CA). As the electrical demand increases, the length of time the arc across the spark plug can be maintained decreases.

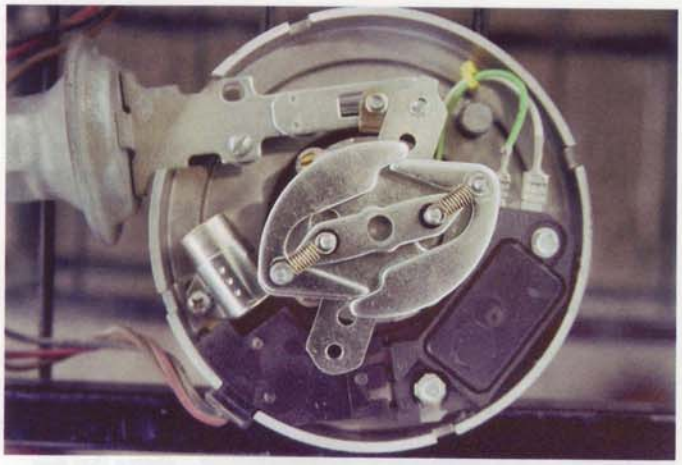
Attaching some numbers to this, an HEI system can arc a spark plug for 2ms and 20 degrees CA. A points ignition would, at best, only support approximately 1.1 to 1.5ms and 10 to 15 degrees CA. At higher engine speeds, the coil has less time to charge. There is even less energy available to keep the spark plug lit and turn the fuel into power.

Ford and Chrysler were not as ingenious with their electronic ignitions. While both were able to eliminate the issue of breaker-point wear, the Mopar unit, though transistorized, still used a ballast circuit, limiting spark output. Ford designed the Dura-Spark with full charging circuit voltage but maintained the fixed dwell period of points. As time went on, almost every automaker in the world copied the Delco HEI design; it is considered by many to be the father of all modern ignition systems.

Servicing the HEI

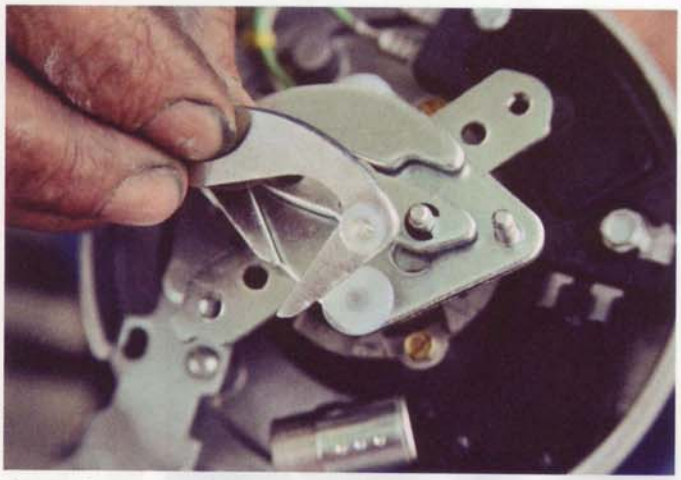
Due to its trouble-free nature, the HEI is an often-neglected component. Since it is electronic, many people seem to believe that if it is working, all must be well. That may be the case, but once a problem does occur, it is important to be able to diagnose it. By following the steps in this primer, you will be able to accurately diagnose and repair any GM HEI system. We traveled to Classic Restoration Enterprises in Pine Island, New York, where technician Richard Wiegand worked with us using a brand-new ACCEL HEI unit to illustrate the inner workings of the HEI and how to service it.

There are three main components in an HEI: the ignition module, the pick-up coil and the integral high-tension coil. The other components of the distributor, such as the mechanical and vacuum advance, gear drive and shaft, are all very similar in function to those found on a breaker-point system. Comparing the HEI components to those in a conventional distributor makes it easier to understand and repair.



This is what you will see with the cap and rotor removed. The vacuum advance connects to the pick-up coil; those leads have a tendency to break from movement. This usually causes the engine to sputter, backfire and possibly stall at light load, though it will run fine at idle or full throttle. If this occurs, a quick diagnostic step is to disconnect the vacuum line so the advance does not function to see how the engine runs. The condenser is used for radio noise suppression.

To remove the distributor advance weights, the springs need to be taken off their moorings by pulling and lifting up.



As part of any tune-up, the weights should be removed, cleaned and lubricated with a small amount of high-temperature grease. Note the nylon slide and pivot bushing.

To remove the module, the leads from the pick-up coil need to be disconnected. Be gentle with the wires, especially with an older distributor.