Electronic Ignition Conversion

Points replacement options

By Bruce Smith

The original ignition in your old car is probably based on induction discharge, also known as contact ignition or basic ignition. The opening and closing of contact breaker points within the distributor induces a current in the coil sufficient to create a spark (the basics of induction discharge ignition are described in the May/June 2016 issue). The breaker points are often considered the weak link of the system for several reasons, including wear that will impact dwell, bounce that can prevent coil saturation, worn cams that will degrade lobe accuracy, and arcing. Contactless ignition systems have been around at least since the 1950s using various approaches to replace conventional breaker points. These have included rotating magnets with sensors, metal detection systems, optical shutters for triggering, reluctor hubs with magnetic pickups, or variations to these approaches. The decades that followed led to the development of conversion kits that could be fit into a car's distributor to upgrade to electronic ignition. In the 1970s, there were over thirty vendors with add-on electronic kits including familiar names like Motorola, Borg Warner, Per-Lux (now Pertronix), and Radio Shack. With today's market limited mostly to pre-1980 era cars, few suppliers remain but they are able to offer technology that has now had many years of field testing. To better understand what sort of electronic conversion is possible with the kits available today, some description of various ignition types might be helpful.

Ignition Types and Terminology

Induction Discharge Ignition (IDI) is what we're probably most familiar with. Output voltages normally don't need to exceed 30K-40K volts, depending on things like cylinder pressure, fuel mixture, plug gap, and temperature. Although some IDI modifications can increase spark energy, conversions addressing charge triggering are the most common.

Capacitive Discharge Ignition (CDI) is sometimes also known as thyristor ignition. In CDI, a storage capacitor is charged with high voltage stepped up from a car's charging system. Capacitor charging and discharging occurs very quickly (typically 1ms), leading to a short duration, high energy spark. To prevent problems with a short spark duration, multiple spark discharges (MSD) can be used. CDI is especially suited for high-revving motors with six, eight, or more cylinders and was first pioneered by Bosch and others for aircraft engines. Early CDI systems were tube-type (thyratron) but replaced later by silicon rectifiers (thyristors) for solid state ignition. Bosch BCDI (where the B stands for battery) was installed in 911s of the 1970s and uses a trigger box with a pulsed charging transformer and a storage capacitor. In BCDI, the control pulse is triggered by the distributor's breaker points and fed to the thyristor, making it conductive and allowing discharge of the capacitor. Though CDI doesn't need a condenser, the systems do use points, the same as IDI systems.

Transistor Assisted Ignition (TAI) is a modified IDI but makes use of a much smaller current (about 100mA vs. 3A) to switch a power transistor and deliver high current with fast voltage rise times. Transistorized ignition can lead to a shorter duration spark with less arcing than traditional IDI systems. Since the points carry only a low current, they will last much longer and there is no need for a condenser. These systems can be quite simple and are often DIY-built.

High Energy Ignition (HEI) is a Delco-Remy electronic ignition system developed in the 1970s and incorporates the ignition coil in the distributor cap. Points are eliminated through use of a control module and magnetic pickup contained in the distributor. This is a popular upgrade for older GM cars.

Electronic Spark Advance (ESA) or Distributor-less Ignition (DLI) is modern ignition that uses an engine control unit (ECU) and sensors to control timing, sending an ignition signal to a transistorized ignitor. With ESA, ideal ignition characteristics can be provided to the engine.

There are other ignition types that may also be referred to as electronic, but these should give an idea of what to consider when upgrading from a basic ignition system. Some of those listed still use points (like CDI and TAI) but do not subject them to the deterioration inherent in an IDI system. Upgrading induction discharge to CDI, HEI, or ESA usually isn't feasible since it would require substantial modification to the ignition system. But there are practical choices for modifying IDI to addresses the weak-link problems with points. Most conversion kits today are based on transistor assistance, Hall-effect sensors, or optical triggering.

Kit Options for Ignition Conversion

TAI electronic ignition conversion - An advantage of transistorized ignition is that the original ignition needs no modification and a plug-in module is possible. Both timing and dwell are set as normal but the issues with high current to the points are eliminated. There have been many how-to articles over the years and kits have been made by Boyer-Bransden since the 1970s. Their units are typically for motorcycles and smaller engines but their Inductive Discharge Unit can also be used in cars. The kit uses a 6V/12V electronics module with a simple three wire connection to the coil, the contact breaker, and ground. With current to the points reduced to less than an amp, points are claimed to last 25,000 miles. An occasional dwell measurement is probably advisable as wear to the rubbing block will still occur. The Boyer-Bransden unit has two status LEDs - one that operates with the points

Three Hall-effect electronic ignition modules: Hot Spark (left), Pertronix Ignitor II (center), and Pertronix Ignitor I (right).

and one to indicate power. I have not tested one but these have been used in thousands of motorcycles and British cars. Beware of claims of improved combustion with a TAI unit like this. Performance will be no better than IDI using a good set of points and proper dwell.

Hall-effect electronic ignition–Some will be familiar with this term used to describe several of the electronic ignition modules available from Pertronix, Hot Spark, Compu-Tronix, and Crane Cams (XR-i). Hall-effect sensors are activated by an external magnetic field to generate a voltage. These sensors are commonly used in switching, speed sensing, and positioning. They work by flowing current through a thin semiconductor material which detects an external magnetic field to generate a small output voltage (a Hall voltage). Because of the low voltage values, a built-in amplifier is usually part of the device. Hall-effect sensors have been used in distributors with rotating magnets as far back as the 1960s. Improvements since then have been mostly in the design of the working parts.

Unlike the options in the 1970s, today's kits are all sort of similar. Some use fixed magnets held in a ring slipped over the cam and a sensor affixed to the breaker plate (Pertronix Ignitor I and II, Hot Spark, and XRi units). The Compu-Tronix unit uses a disk with surface mounted magnets that travel above a sensor. Three Hall-effect kits are shown above – two from Pertronix and one from Hot Spark. Each of these use a magnetic ring which fits under the original rotor.

Installing any one of these into a distributor is fairly simple. Variations of each type are based on how they fit onto a distributor's breaker plate. Pertronix sells model #1844 for cast iron Bosch distributors like the BR18 and 022, with different versions for 12V and 6V. For 031 distributors, the model is #2847 and for 050's it is #1847. Hot Spark makes more universal fit 12V 4-cylinder versions with the 3BOS4C2 for two-piece points and 3BOS4UL1 for one-piece points. Compu-Tronix sells a model for one-piece points only. The Crane Cam XRi doesn't support 4-cylinder distributors.

As with any add-on ignition module, it is important that the resistance and voltage values in your car's ignition meet certain requirements. These may not need you to make any significant alterations other than verifying that you're using a suitable coil and have enough voltage. The 12V Hot Spark and Pertronix Ignitor I units can be used with a 30KV coil rated at least 3 Ohms primary internal resistance (no in-line ballast resistance). For 6V units, 1.5 Ohms or more is needed. These requirements can be met with standard Bosch coils but using too low resistance can overheat or damage the ignition module. Having sufficient voltage and current are critical for a Hall-effect sensor to operate. This is especially true for 6V systems (more about this later). Detailed instructions for testing resistance and charging voltages are provided with these units and should be followed carefully.

Of the two Pertronix units, the Ignitor I is probably adequate for use with most 4-cylinder motors. The Ignitor II is designed as a higher energy version, especially at revs above 3000 rpm. These need a lower resistance 40KV coil, and a standard one won't do. In addition to delivering a stronger spark, the dwell of the Ignitor II is adaptive, meaning that sufficient charging time is assured even at the highest speeds. The issue of charging time was addressed in the May/June 2016 *Registry* article, which can be verified by testing these modules on a distributor machine. The pictures below show distributors with kits installed and mounted in a Sun distributor tester. Though not a standard test set-up, dwell angle (and corresponding dwell time) can be measured by providing external power to the Hall-effect sensor. Test results give insight into how each unit is uniquely designed to charge a coil and provide a spark. *Continued*

Electronic ignition modules installed in distributors: the Hot Spark in a 022 distributor (left), the Ignitor II in a 050 distributor (center), and the Ignitor I in a BR18 distributor (right).

The dwell angle on the Ignitor I measures 47° throughout the rev range up to 5000 rpm (at the crank), which is within the 50° +/-3° dwell spec for points. This corresponds to about 20 milliseconds to energize the coil at 800 rpm and about 3 milliseconds at 5000 rpm. The dwell angle with the Ignitor II changes with speed and measures 26° at 800 rpm increasing to 80° at 5000 rpm. This correlates to about 11 milliseconds and 5 seconds at these revs respectively – more time than the fixed dwell Ignitor I at higher revs. For 4-cylinder motors, 3 milliseconds with a fixed dwell is sufficient but the dynamic dwell of an Ignitor II could be useful for high revving 6+ cylinder motors. With the Hot Spark module, the dwell also varies but at lower values. The dwell time at 800 rpm correlates to about 8 milliseconds and at 5000 rpm it is about 2 milliseconds.

Cam lobe accuracy is also an issue with an old worn distributor. Below is a picture of the cam lobes from a Bosch distributor that has seen a lot of miles, some which were probably with no cam grease under the rubbing block. The variation between lobes on a distributor like this can be as much as +/- 2°, even more. The lobe accuracy spec on a new distributor is normally better than +/-1°, taking into account all contributions from the shaft, points, and rubbing block. Once this 1° is surpassed, the errors become significant relative to the distributor's static and full advance at the crank. A solution to a worn out cam is to replace cam triggering with something else, like the sleeved rings or disks in a conversion kit. Testing lobe accuracy on a distributor machine is straight forward and the results for these units were all quite good. The Ignitor I showed an accuracy across all four lobes of +/- 0.5° and both the Ignitor II and Hot Spark measured +/-1°. All are at least as good as what should be expected with cam lobes in most 50 year old distributors.

A heavily worn cam on a 50+ year old distributor leading to variation between the lobes.

Optical sensors and transistor-assisted ignition

Over the years, several vendors have developed optical triggering and electronic sensors to replace points. Allison Automotive was probably the most successful with a unit that eventually became the XR700, now sold under the Fireball name by Crane Cams. An IR LED and sensor are mounted to the distributor's breaker plate with a slotted disk mounted to the cam. The rotating disk interrupts the light shining on the sensor, timed to the cylinders and based on size and spacing of the slots. These units also use original rotors and need no other modifications to the distributor. Crane Cams also makes an optical trigger module for capacitance discharge (CDI) boxes, but the XR700 is the one for induction discharge.

A Fireball XR700 is shown above, mounted in a Porsche 912. The optical trigger is installed in a Bosch 050 distributor and the ignition module is mounted to the fender wall. The plastic shutter fits over the distributor cam, with detents to align with the lobes. The width of the slots dictates the dwell time. Wiring is quite simple, with connectors at the sensor unit and the ignition module. It's compatible with a standard 30KV Bosch coil with 3 Ohm internal primary resistance. Some alignment of the optical sensor is usually needed to assure that the rotor and shutter align with cylinder terminals. A main advantage of using an optical trigger is the accuracy of the timed spark and dwell. With slots cut into the plastic shutter,

A Fireball XR700 installed in a 912 with the ignition module on the firewall (left) and optical sensor in the distributor (right).

there is more certainty than is possible with a points block or with a rotating magnet ring. The main downside of these units are their susceptibility to dirt, which can block the detector and weaken the signal. The unit pictured has been installed in the car for several years with no problems so far. And it seems easy enough to clean if needed.

Will this work in a 6V car?

With all of this said, I'm still a fan of using breaker points in old cars. With the limited miles that mine are driven, changing points doesn't happen very often. Yearly tune-ups confirm dwell settings and carrying a spare condenser is pretty simple. But having the Fireball XR700 in our 12V 912 is nice assurance that the ignition is at its best, as should also be the case with a Hall-effect unit – as long as they remain reliable. The ignition conversion choices for 6V electrics are unfortunately more limited. Although the technology of optical triggering could be designed for 6V, the option is not available in a Fireball XR700. The TAI Induction Discharge Unit from Boyer-Bransden works with either 6V or 12V systems, and indeed has been used for years in both. The current needed to relay high voltage could be met with most electrical systems. A Hall-effect sensor can be a bit more difficult. Pertronix does offer the Ignitor I for 6V cars. But will it really work in an old 6V ignition? Well, maybe.

The current for a Hall-effect sensor needs to be large enough to generate a voltage from a passing magnetic field. The gap between the two is on the order of a few millimeters and the field isn't terribly strong. That, however, isn't the entire issue. The problem is more likely that a car with 6V electrics is very old and apt to have excess system resistance from poor connections, old wiring, and so forth. The low system voltage together with high wiring resistance reduces the available current to the sensor (as per Ohm's Law). And without enough current, the resulting Hall voltage is weak. Some have had luck with Pertronix in 6V systems, while many others have not. There are probably two avenues to consider if you'd like to install one in your 6V car. One option is to ensure that your charging system is outputting about 7.5 V or more, that all sources of resistance are corrected (connections, old wiring, etc.), and that you've got a good strong battery. But this may still not be sufficient, as a normal voltage drain may be enough for the sensor to drop out. The other option is to upgrade your car's electrics to 12V and use a Pertronix, Hot Spark, or Compu-Tronix 12V unit. Otherwise, you may want to stick to using breaker points. But if your distributor cam is worn too far, using points may no longer be an option. Whichever way you go, keep in mind that a breaker point set-up in good condition can usually give comparable performance to a kit-converted electronic ignition.

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