

Three, Two, One...Ignition

Styling and look-of-eagles imagery capture our fancy, but true progress creeps in on little cat feet, attracting scant notice and creating no excitement. Real advances are neither way cool nor bitchin'; they are usually

By Gordon Jennings

hidden and hard to understand, never more so than when electronics

are involved.

One relatively recent bit of change in motorcycle technology is electronic engine management, which has been given a lot of attention in the context of fuel injection. Still, the greater advantage of digital technology is what it does for engines' ignition systems.

Motorcycle ignitions have always been inferior to those that spark automobile engines. The spark-voltage inferiority is reflected in the recommended plug gaps, which rarely exceed 0.35 inch for late-model bikes. Cars' plugs are rarely gapped closer than 0.45 inch. Wide plug gaps put a larger volume of air/fuel mixture between the plug's electrode and ground. Such mixtures are not perfectly homogeneous: The gases in the plug gap are too rich or too lean to fire in most places and are ignitable only here and there. A gap of 0.35 inch contains 71 percent more mixture than

one 0.25-inch wide, and gives the spark a 71 percent better chance of hitting an ignitable area.

A spark big enough to ignite the plug gap's air/fuel mixture is not all the spark an engine needs. A delay of roughly 10 degrees of crank rotation follows the best of sparks before a fire begins to spread through the combustion volume. Weak sparks vary the delay: when a good mixture is in the plug gap, the fire they start blossoms and quickly spreads. But most sparks will not strike in such favorable conditions, which means longer delays even when no actual misfire occurs. The result is exactly the same as if the ignition timing you'd set at 25 degrees before top dead center wobbled erratically between 15–25 degrees.

Motorcycles' ignition systems have made a long climb from the hopeless inadequacy reflected in 0.18-inch recommended plug gaps. They now are all the way up to 0.35-inch mediocrity, still 22 percent under the automotive stuff but 194 percent better than we had in the bad old days, and probably sufficient unto our purpose.

Electronic switching improves spark-coil output. Ignition coils are high-ratio transformers, which pump up electrical system line voltage to the 10–15 kilovolts needed to push a spark across the plug gap. Voltage derives from the primary/secondary windings ratio and can be had from quite small spark coils that do not meet the second requirement for reliable ignition, which is spark energy. Energy comes from the intensity of the magnetic field created in the coil by the heavier gauge, less numerous primary windings.

For decades, spark energy was limited by the current capacity of mechanical switching, with contact points opened and closed by a small cam. Mechanical breaker points can handle current loads of about three amperes, but for sparks that can fire lean-limit mixtures into instant action you need at least five amps and electronic switching. Some of the new automotive "transistorized" ignition systems have coil primary currents in the eight-amp range and outputs so high they rate a warning label.

Thanks to digital electronics, we're seeing big improvements in spark timing. After the ancient days of manual spark-control levers, we got automatic ignition advancers, commonly in the form of flyweights restrained by springs, which retard the spark timing for starting, then move it ahead with rising engine speed. These devices typically reach maximum advance at less than 2500 rpm. Their function is to facilitate starting and idle-condition running. At all higher engine speeds, spark advance is fixed.

Motorcyclists have had one-setting-suits-all ignition systems for so long that the rightness of this expedient is rarely questioned, except by grouches like me. But conditions within the cylinders of a running engine vary and are best served by appropriate adjustments in ignition timing.

At light throttle, the air/fuel charge packed in the combustion chamber is, well, loosely packed. The fire ignited by the spark plug spreads relatively slowly under such conditions, so more spark advance is needed. Opening the throttle

results in a more tightly packed charge, more rapid combustion and a need to reduce ignition advance. Our traditional fixed-advance systems do not even acknowledge such variables exist. Further, charge density is not simply a function of throttle opening, nor is flame propagation linked solely to charge density. The rate at which fire spreads in a combustion chamber is determined by both density and turbulence. Broadly speaking, the swirl of the combustion chamber's contents increase in proportion with engine speed, producing a rising burn rate to offset the reduced time available at higher crank speeds. This is why fixed timing advance has been judged satisfactory for so long.

Those few of us who get to tinker with engines driving dynamometers have long known that maximum power over a broad operating range is obtained only by adjusting the spark advance to suit each engine test speed. The least amount of advance in the operating range will almost always be needed at peak torque, as charge density is then at its highest. More advance has always been optimal for other engine speeds at full throttle and as you throttle back.

Knowing the above meant nothing in the pre-digital-electronics era. We were able to find the best ignition advance for all combinations of engine speed and throttle openings, but had no way of applying that knowledge. Now all that fine tuning can be provided by a small computer that waits for pulses from a signal generator on the crank. As each pulse arrives, the box checks for throttle position, calculates engine speed, reads from a stored memory of the engine's habits, then counts off an appropriate interval and delivers a spark at precisely the right moment.

Digitally controlled, mapped ignition systems have been used on GP racing motorcycles for a decade or more. Now they are a standard feature on most high-performance streetbikes, a sign that motorcycling is adding value in a long-neglected technological area. It isn't the stuff of which riveting advertising copy is made, but it's progress of a seriously significant kind. **MG**

You'll find me on WheelBase, an online service for motorcycle and car enthusiasts. We're on the Internet at <http://www.wheelbase.com>; my e-mail address is gj@wheelbase.com; or you can call me at (805) 239-8707.

For decades, spark energy was limited by the current capacity of mechanical switching, with contact points opened and closed by a small cam.