HALL EFFECT CRANKSHAFT SENSORS

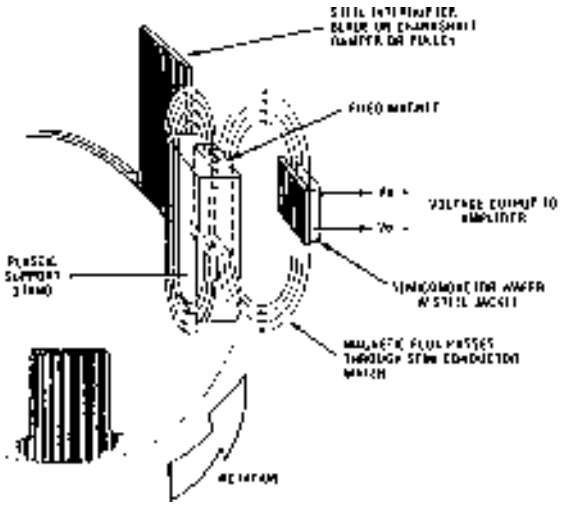
The "Hall Effect" or "Hall Voltage" was named after Dr. Edward Hall, the physicist, who made the discovery. In principle, a controlled voltage from the ignition module is routed to a semi-conductor wafer in the Hall Sensor. A permanent magnet positioned beside the semi-conductor induces Hall voltage across the semi-conductor (see Illustration 1). The crankshaft sensor is positioned in such a manner that its metal blades (mounted on the crankshaft balancer) pass between the semi-conductor and the permanent magnet. As the blade rotates through the vanes in the sensor (see Illustration 2), the signal voltage oscillates from a low to high state, generating a square wave signal. The ignition module and ECM use these signals to maintain correct ignition and fuel injection timing.

SIMILAR BUT BETTER

A "Hall Effect" sensor is similar to a magnetic pulse unit in that it uses a stationary sensing unit and a rotating trigger wheel. The Hall sensor has a distinct advantage over magnetic pulse units (pick-up coils), especially at lower speeds. Full output voltage is present at lower speeds and it is not changed by the speed of the trigger wheel.

HALL EFFECT CRANKSHAFT SENSORS

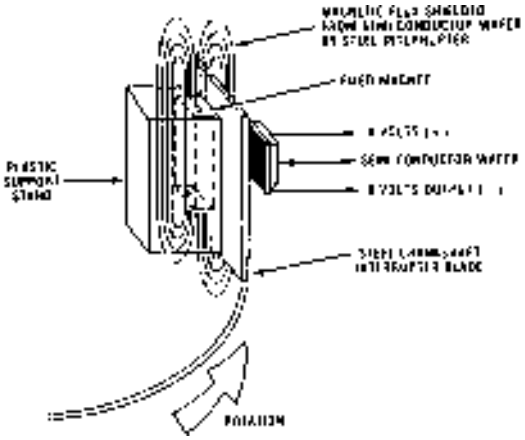
While the material in this bulletin is directed toward driveability problems associated with crankshaft sensors, a companion sensor (the camshaft sensor) must also be considered when



HALL SWITCH ON

ILLUSTRATION COURTESY OF GENERAL MOTORS

ILLUSTRATION 1



HALL SWITCH OFF

ILLUSTRATION COURTESY OF GENERAL MOTORS

ILLUSTRATION 2

trouble-shooting a no-start condition. Some systems use a camshaft sensor in addition to a crankshaft sensor. Other systems may use a combination sensor which includes both sensors built into one unit with two interrupter rings on the crankshaft damper.

THEORY

In condensed theory the system functions this way: The crankshaft and camshaft sensors are connected directly to the module. The module receives and sends a reference and camshaft signal to the ECM. During cranking, the module receives a signal from the crankshaft sensor; however, it will not fire the coils until it sees a reference pulse from the camshaft sensor. Once it receives the camshaft pulse, it will fire the coils in the proper sequence. If the camshaft signal is lost after the engine is running, it will continue to run, but it will not re-start once the engine is shut off. The module will not fire the coils because it doesn't know when #1 cylinder is at top dead center; therefore, it cannot determine the proper firing sequence. If at any time the crankshaft signal is lost, a loss of spark will occur immediately.

EXCEPTIONS TO THE RULE

There are exceptions to the mentioned theory. For example: The C3I Fast Start System on GM's 3800 engine uses a dual crankshaft sensor and a separate camshaft sensor. This system can start and run with a defective camshaft sensor (in the walk-home protection mode). Another example is the 3.0L which may start if the sync signal is pulled low and the driver repeatedly tries to start the engine. If this circuit is pulled low while the engine is running, the module will re-sync and the engine usually stalls. In the case of the 3.8L and 3.8L turbo, an open or grounded camshaft signal will result in the ECM terminating sequential fuel injection and instead firing all injectors at once. If this occurs, the engine will not stall, but will experience degraded performance and economy, plus high emission output.

ADJUSTMENTS

The crankshaft sensor must be adjusted. The required adjustment has nothing to do with timing. Instead, it prevents damage to the sensor. Follow the recommended procedures and specifications supplied by the vehicle manufacturer for the type sensor being adjusted. Also, crankshaft sensors are subject to damage from road debris. Inspect and replace any sensor which shows evidence of coming in contact with the interrupter ring. If the adjustment cannot be made, replacement of the interrupter ring may be necessary. Any rubbing or interference can result in poor performance, plus damage to the sensor.

A defective or mis-adjusted camshaft sensor can result in the sensor signal being 180 degrees off. The engine would still run because the module doesn't care if the piston is at top dead center compression or exhaust. However, the injectors would spray after the intake valve closed. The result would be poor performance and/or backfiring through the intake manifold.

ERRONEOUS SIGNALS

A marginal crankshaft sensor can fool the best of the techs. A bench or signal test can indicate the sensor is functioning properly. However, install it on a vehicle and perform a road test and you may have a different opinion.

If your testing efforts fail to identify the culprit and the symptoms involve a miss, hesitation, stall, chuggle or fish-bite, try a crankshaft sensor. Refer to the included "Case of the Cranky Sensor" for some case histories of marginal sensors.

LARRY HAMMER
TECHNICAL SERVICES

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THE CASE OF THE CRANKY SENSOR

It Can Test the Best of Man and Machine

— *By* Larry Hammer / *Mighty Auto Parts*

The Olds had faked out more than one technician. The 3.8L engine equipped with multi port fuel injection and a distributorless ignition system had been showered with enough parts to qualify it as a parts warehouse.

The complaint was simple. It had a miss. The customer whipped out a checklist of repair shops plus one dealership who had attempted to resolve the complaint. Parts replaced included spark plug wires, coil pack, fuel pump, mass air flow sensor, air filter and seven sets of spark plugs. *Seven!* With fire in his eyes, he asked for a written guaranteed estimate to repair his car.

THE CHALLENGE

A technician friend and shop owner took on the challenge (except for the written estimate). Two days later, arriving at my home, I was greeted by the same technician. The man looked as if he had been run through a pipe bending machine. "Got a minute for a road test?" he asked. As we proceeded, I was briefed on the history of the numerous attempts to correct the problem. The glove box hinges sagged from the massive collection of repair tickets.

The symptoms were those of a defective spark plug or plug wire breaking down under load. Engineers sometimes refer to it as chuggle or fish-bite.

Our road test ended at my friend's shop where we hooked up a piece of diagnostic equipment that cost twice as much as my first home. We re-created the symptom, hoping to come up with a clue. But there was nothing on the expensive machine except a momentary erratic secondary display. Seemingly, we were experiencing a transient interference or an ignition loss for only a second. My friend was thinking … the module. I wasn't convinced. Prior to leaving my driveway I had asked if the *crankshaft sensor* had been replaced. The response was "What's that got to do with it?" An engineer had advised me to replace the crankshaft sensor when everything else tested good or had been replaced in a futile effort. I had fixed a few by following his advice. After much deliberation over the module and crankshaft sensor it was agreed he would replace the sensor the next morning and call me with the results. Next day, the phone never rang. However, that afternoon he was back in my driveway. This time all smiles. "We fixed it," he said. "What fixed it?" I asked. *"The crank sensor.* I put fifty miles on 'er and she runs perfect!" The lengthy road test implied he had serious doubts and was still wondering what it had to do with it.

GETTING A HANDLE ON IT!

A few days later I'm visiting another repair shop which also enjoys the reputation of the place to go when the vehicle won't. A technician was diagnosing a similar vehicle for a stalling condition. As I observe, he meticulously moves wiring and connectors, eliminating the basics. Attached and positioned around the vehicle is diagnostic equipment which cost twice the sticker price of the car. He walks to one corner of the shop and picks up a round object approximately one inch in diameter and four feet in length — *a mop handle!* In addition, he picks up a two pound shop hammer. Cautiously, he inserts the handle through a maze of plumbing, pulleys, belts and hoses and positions it on the crankshaft sensor. With everything clear, "Fire 'er up!" he commands to a helper. With the engine idling, he gently taps the end of the handle with the hammer. Immediately, the engine stalls. Twice more the procedure is repeated and each time the engine stalls. Watching intently, as I had never seen anyone test a crank sensor with a mop handle, I asked the helper to re-start the engine and get out of the car. Reason? More than once these fellas had set me up and left me hanging for days. "Now tap the mop handle." He obliged and the engine stalled.

"Man, I never heard of anyone beating a crankshaft sensor with a mop handle. How did you know how to do that?" "I remembered the tap test for the mass air flow sensor and wondered if it would work on the crankshaft sensor. Sure enough, it has detected two additional intermittent sensors."

A WORD OF EXTREME CAUTION

The tap test is not conclusive for all marginal crankshaft or mass air flow sensors. If you try the tap test on a crankshaft sensor, *extreme caution* should be taken. One slight distraction could turn a good mop handle into splinters, damage the vehicle and cause serious bodily harm. And watch your fingers; don't send them down the pathway of a belt drive assembly.

If you can't identify the problem component involving a stall, miss, fish-bite or chuggle, try a crankshaft sensor. It may eliminate frustration and make your customer very happy! ■

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