DELCO-REMY ELECTRONIC SPARK TIMING (EST) IGNITION SYSTEM

General Motors
Buick
Cadillac
Chevrolet (Exc. Fed. Chevette w/o 5-Speed)
Oldsmobile
Pontiac (Exc. Fed. T1000 w/o 5-Speed)

DESCRIPTION

The Delco-Remy High Energy Ignition system with Electronic Spark Timing (HEI-EST) is used on all General Motors vehicles equipped with gasoline engines. The 4.1L VIN 4, 5.0L VIN 7 and 5.7L VIN 8 (Corvette) engines also use the Electronic Spark Control (ESC) system to retard spark timing when detonation occurs.

The Delco-Remy HEI-EST system, a part of all General Motors Computor Command Control systems, is designed to provide optimum performance through electronic control of air/fuel ratios, spark timing, air management and idle speed.

The distributor has neither vacuum nor centrifugal advance mechanisms. *See Figs. 1 and 2.* The distributor contains a 7-terminal HEI-EST control module, a timer core, pick-up coil, radio noise suppression capacitor and, on most models, an integrally mounted ignition coil, located under the distributor cap's coil cover. Distributors on vehicles equipped with 2.5L VIN 2 and 3.8L VIN K engines also contain a Hall Effect switch and shutter blades.

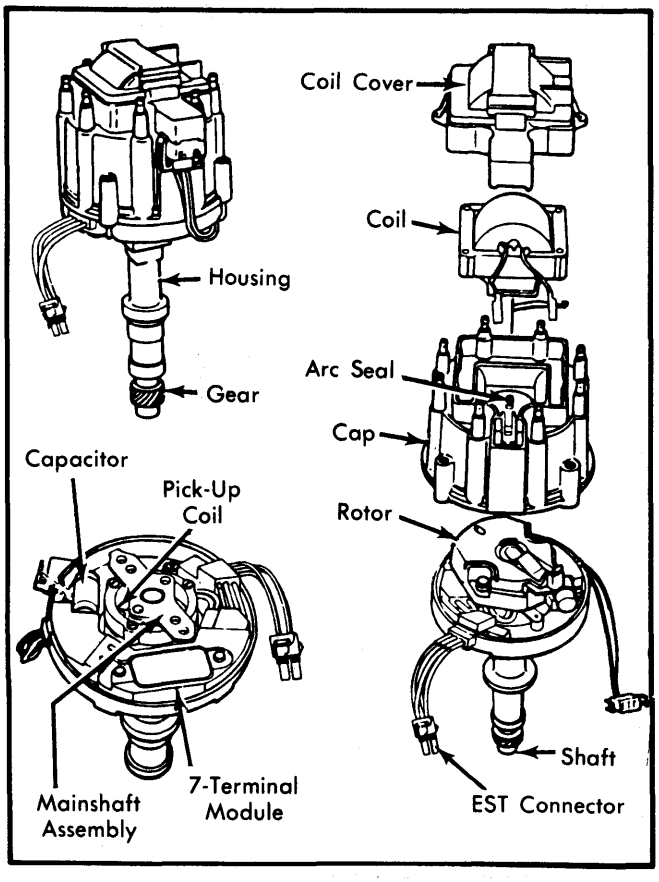

Fig. 1 Disassembled View of EST Distributor (Model with Integral Coil Shown)

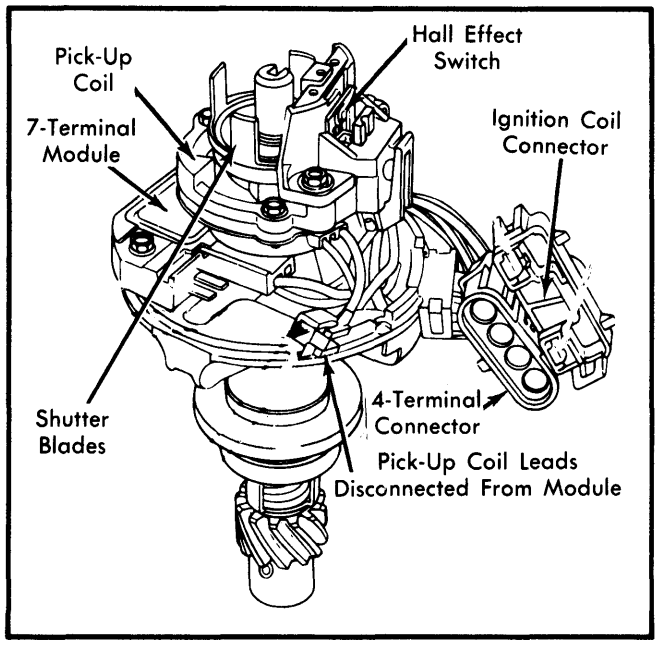

Fig. 2 HEI-EST Distributor with Hall Effect Switch (External Coil Model Shown)

NOTE – *On all models equipped with 4-cylinder engines, the ignition coil is mounted externally. On all other models, ignition coil is mounted on distributor cap.*

The Hall Effect switch and shutter blades act as a second pick-up coil and timer core. When the engine is in the cranking mode, the pick-up coil and timer core are used to send impulses to the ECM. When the engine is in the run mode, the Hall Effect switch and shutter blades perform this function.

On 2.5L VIN 2 engines, the shutter blades point upward since the ignition coil is mounted externally (not in the distributor cap). On 3.8L VIN K engines, the shutter blades point downward to provide space for the distributor cap mounted (integral) ignition coil. The number of shutter blades must equal the number of cylinders in the engine being used.

The distributor is connected to the EST system by means of a 4-wire connector, leading to the external electronic control module (ECM). The ECM (not the distributor HEI-EST module) receives voltage signals from a number of sensors. A typical system could be provided signals from oxygen, engine coolant temperature, throttle position, barometric pressure and manifold absolute pressure sensors, as well as the distributor pick-up coil and Hall Effect switch (if equipped).

CAUTION – *Few components are interchangeable between HEI-EST and HEI distributors used on various engines. Be sure correct part is used, as similar appearance does not mean identical design or operation.*

The HEI-EST module in the distributor has 7 terminals. The ignition coil battery terminal (positive) is connected to the "B+" or "B" terminal, the coil's "TACH" or negative terminal to the "C" terminal. *See Fig. 3.* Terminals "N" and "P" are attached to the pick-up coil. HEI-EST module terminal "R" connects through the EST connector "B" to ECM terminal 10 (Distributor Reference Pulse Hi). Terminal "B" connects through terminal "C" to ECM terminal 11 (Ignition Module By-pass). Terminal "E" connects through connector "A" to ECM terminal 12 (EST). ECM terminal 13 (Distributor Reference Pulse Lo) connects to connector "D" and then to HEI-EST module ground.

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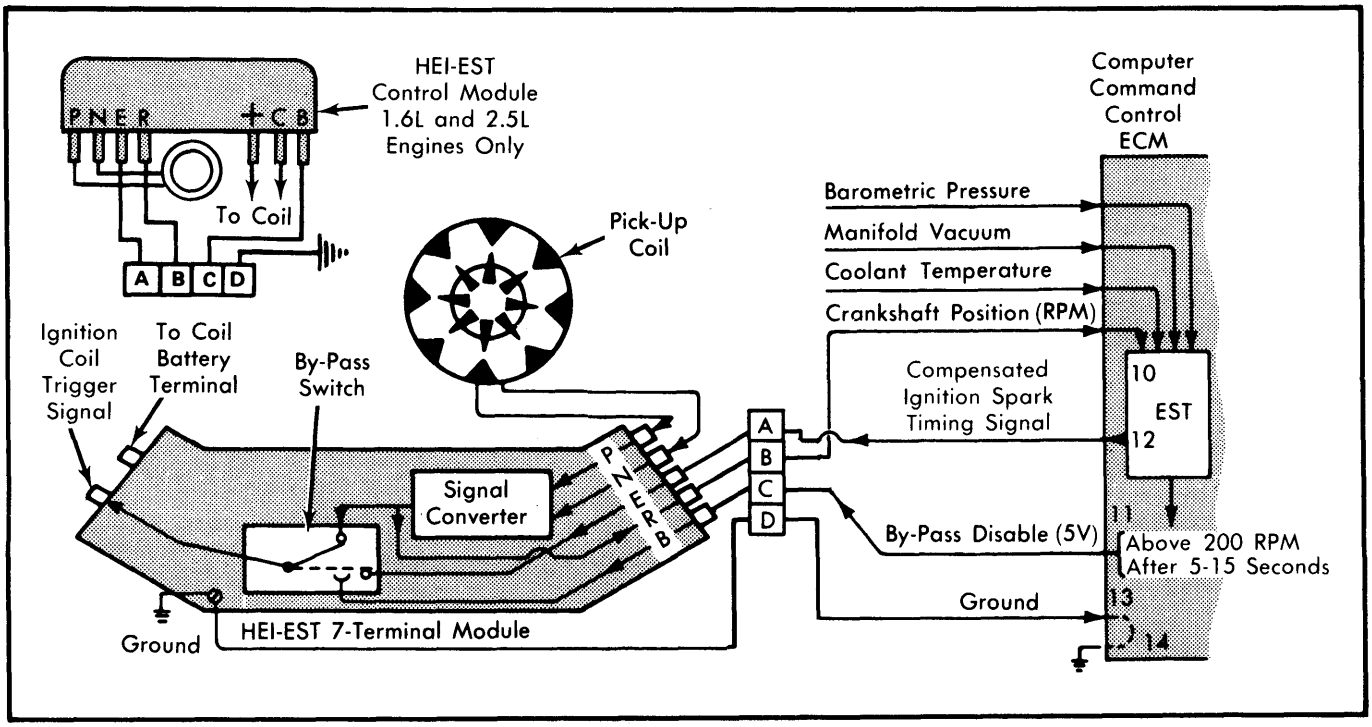

Fig. 3 Schematic of HEI-EST Ignition System Including Relationship To Computer Command Control Electronic Control Module

There are 4 basic components to the ESC system: A detonation sensor, and HEI-EST distributor, an ESC controller, and the ECM. When detonation (engine knock) occurs, the detonation sensor sends an electrical signal to the ESC controller. The ESC controller amplifies this signal and transmits it to the ECM which then retards the spark advance until it no longer receives a signal from the detonation sensor, through the ESC controller.

OPERATION

During cranking or in event of EST ECM failure, a by-pass signal from ECM terminal 11 to the HEI-EST module terminal "B" is either absent or low. See *Fig. 3*. This notifies the HEI-EST module to take over control of spark advance and to ignore any EST information coming from the ECM. During this period, poor engine performance may result under some conditions, but the diagnostic "CHECK ENGINE" light will not come on.

The HEI-EST module will then convert pick-up coil RPM signals and transmit them through the by-pass switch and terminal "C" directly to the negative "TACH" terminal of the ignition coil. These signals turn the coil primary circuit on and off, causing a surge in the secondary that fires the spark plugs.

When engine speed reaches 600 RPM or more (about 5-15 seconds after starting), the ECM transmits a constant 5-volt signal to the distributor HEI-EST module, changing the position of the by-pass switch. This has the following effect:

- On models equipped with a regular distributor (without a Hall Effect switch), the pick-up coil's RPM signals can no longer flow directly to the ignition coil as this circuit is now open. Instead the signals are converted in the distributor module and routed through terminal "R" to ECM terminal 10.

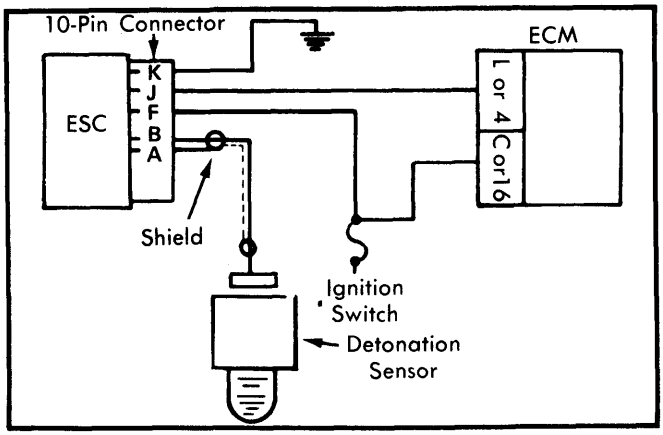

Fig. 4 Schematic of Electronic Spark Control System (ESC)

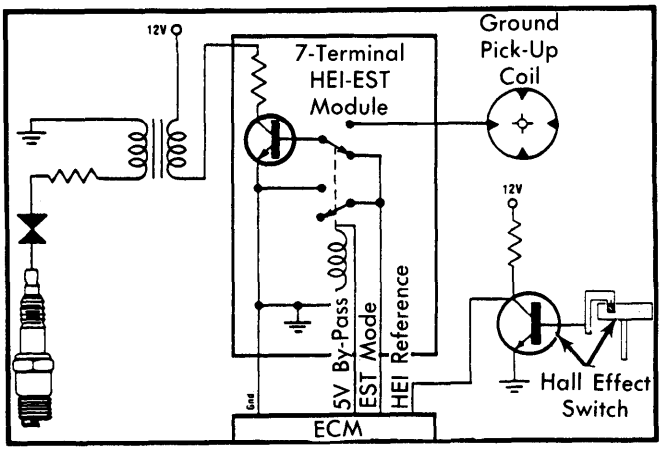

Fig. 5 Schematic of HEI-EST Ignition System With Hall Effect Distributor

DELCO-REMY ELECTRONIC SPARK TIMING (EST) IGNITION SYSTEM (Cont.)

- On models equipped with a distributor having a Hall Effect switch, the change in position of the by-pass switch opens the circuit between the pick-up coil and ignition coil. The pick-up coil has no RPM reference connection to the ECM, as HEI-EST module terminal "R" is not used. The function of supplying RPM signals to the ECM is then accomplished by the Hall Effect switch. The wires from the Hall Effect switch connect directly to the ECM and do not connect to the distributor module.

The PROM (Programmed Read Only Memory) portion of the ECM carries the basic spark advance curve based on engine RPM. Spark timing is calculated by the ECM whenever an ignition pulse is present, however, spark advance information is only SENT TO the distributor when the engine is running (not during cranking). Engine sensor values are used by the ECM to modify the PROM information, increasing or decreasing spark advance to achieve maximum performance with minimum emissions.

The coolant temperature sensor advances spark on a cold engine and reduces advance as engine reaches normal operating temperature. If engine is too hot, spark is retarded to prevent detonation.

During light throttle operation, the throttle switch allows for additional advance. Additional adjustment results from input from coolant temperature, engine RPM and manifold absolute pressure (MAP) sensors. When MAP is low, spark is at maximum advance.

As load increases and pressure increases, spark timing is retarded to allow the engine to maintain its performance and emission level.

After computation of all information from the various sensors, a compensated ignition spark timing signal is sent back to the distributor through the HEI-EST module's "E" terminal to the by-pass switch, "C" terminal, and ignition coil negative terminal. Each time the signal is flashed on and off, the coil's primary circuit is turned on and off. As this occurs, a voltage surge occurs in the secondary that fires the spark plugs.

The ECM is continually computing sensor information to maintain efficient engine performance with low emission levels, doing so under varying engine conditions.

NOTE – *The shape of the HEI-EST module used in the 2.5L engine differs from that of other HEI-EST modules. However, it also has 7 terminals and operates in the same manner.*

PRE-TESTING DIAGNOSIS

If the reference or EST signals are interrupted due to open wires or a faulty ECM, the vehicle will still run. The HEI-EST module will provide a timing signal based on engine RPM.

If the by-pass signal is lost, the ECM cannot control spark timing, as the by-pass switch will permit direct flow of information to the ignition coil rather than to the ECM.

Normally, a few seconds (5-15 seconds) after starting a warm engine, the by-pass signal electronically operates a by-pass switch in the HEI-EST module. The HEI-EST module's RPM-controlled timing signal no longer can flow directly to the ignition coil, but is diverted first to the ECM for modification by information from the engine sensors.

Loss of the EST signal with the by-pass signal "ON", however, will stop the engine, because the HEI-EST module is no longer sending signals directly to the ignition coil, but to the ECM, and any loss of the EST signal cuts all flow to the coil. If an attempt is made to restart the vehicle, the engine will run for a few seconds and then stop when the by-pass signal comes back on.

TESTING

IGNITION COIL RESISTANCE CHECK

Externally Mounted Coil – 1) Remove coil connector. Using the low scale, connect ohmmeter leads to coil's battery and "TACH" terminals. See *Fig. 6*. Resistance should be 0-1 ohms. If not, replace ignition coil.

2) Set ohmmeter on high scale and connect leads to battery terminal and a good ground on coil. Reading should be infinity. If not, replace coil.

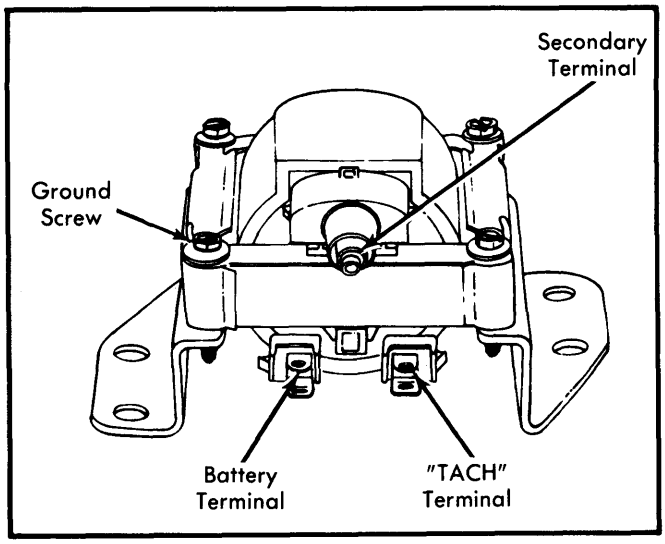

Fig. 6 Ignition Coil Resistance Test Points (External Type Coil)

3) With ohmmeter still set in high range, connect leads to "TACH" terminal and to secondary terminal. Reading should be 6,000 to 30,000 ohms. If not, replace coil.

Integrally Mounted Coil (In Distributor Cap) – 1) Turn ignition switch "OFF". Remove distributor cap and coil assembly. See *Fig. 7*. Set ohmmeter in low scale. Connect leads to coil's battery and "TACH" terminals. Resistance should be 0-1 ohms. If not, replace ignition coil.

2) Set ohmmeter in high scale. Connect ohmmeter leads to coil secondary and "TACH" terminals. Resistance should be infinity. If not, replace coil.

3) Connect ohmmeter leads to ground and secondary terminals. With ohmmeter still set in high scale, resistance should be 6,000-30,000 ohms. If not, replace ignition coil.

DELCO-REMY ELECTRONIC SPARK TIMING (EST) IGNITION SYSTEM (Cont.)

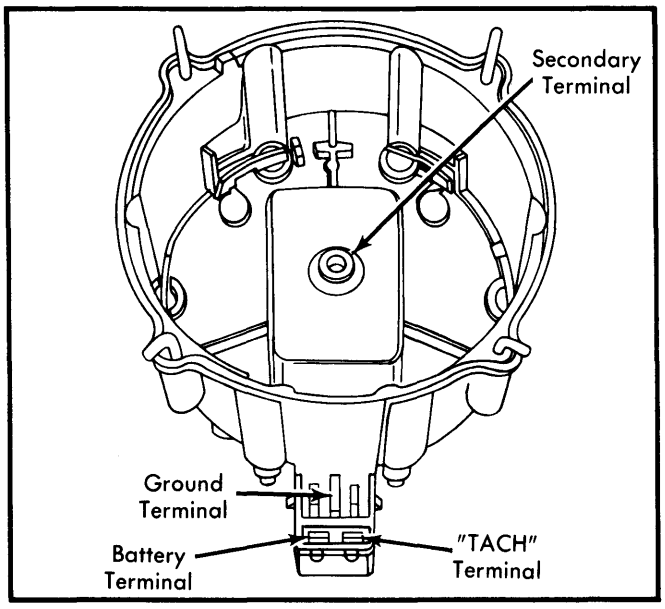

Fig. 7 Ignition Coil Resistance Test Points (Integral Type Coil)

DISTRIBUTOR PICK-UP COIL SHORT AND RESISTANCE CHECKS

1) Disconnect pick-up coil leads from HEI-EST module "N" and "P" terminals (usually a Green and a White wire). To check for shorted pick-up coil, set ohmmeter in middle range. Connect one lead to either pick-up coil lead and other lead to distributor housing. See *Figs. 8 and 9*. Reading should be infinite. If not, replace pick-up coil.

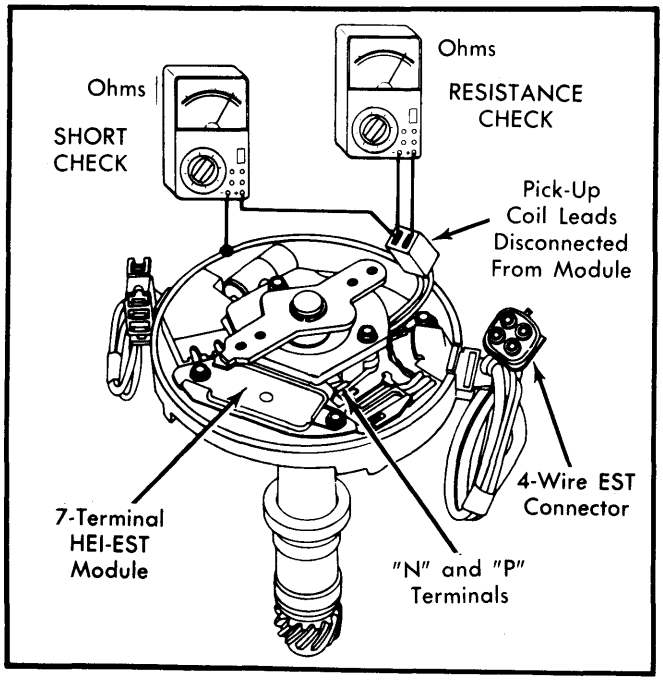

Fig. 8 Distributor Pick-Up Coil Short and Resistance Checks (Integral Coil)

2) Connect ohmmeter leads to both pick-up coil leads, while flexing wires and connectors to locate intermittent opens. See *Figs. 8 and 9*. Resistance should read a constant unchanging value between 500 and 1500 ohms. If not, replace pick-up coil.

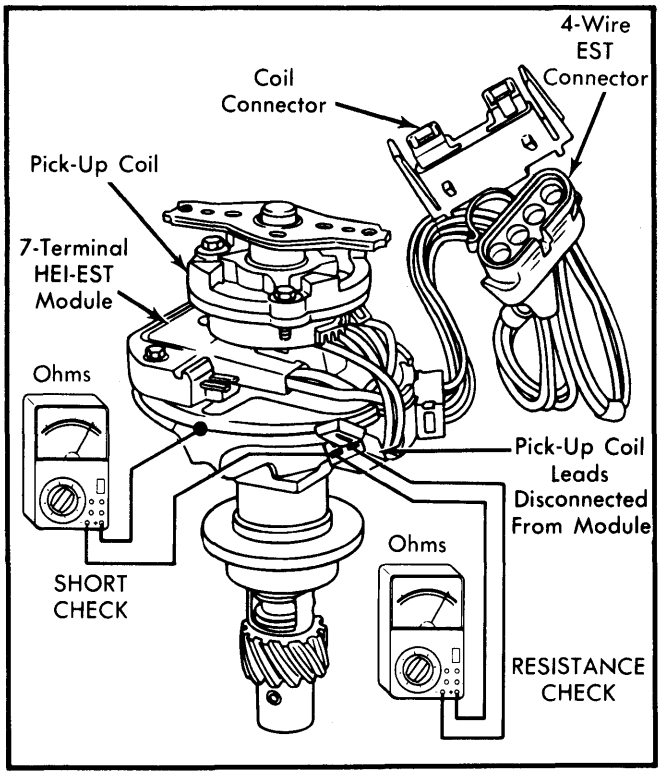

Fig. 9 Distributor Pick-Up Coil Short and Resistance Checks (External Coil)

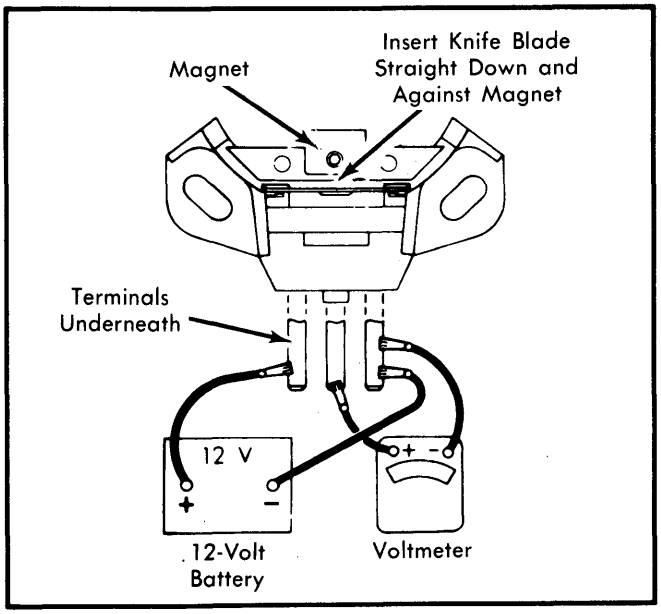

Fig. 10 Testing Hall Effect Switch

DELCO-REMY ELECTRONIC SPARK TIMING (EST) IGNITION SYSTEM (Cont.)

HALL EFFECT SWITCH TEST

NOTE – *Hall Effect switches cannot be checked with an ohmmeter like a pick-up coil.*

1) Disconnect 3-wire connector at Hall Effect switch. Connect a 12 volt battery and voltmeter to switch terminals. *See Fig. 10.* Carefully note polarity markings.

2) Insert knife blade straight down between magnet and Hall Effect switch. *See Fig. 10.* Voltmeter should read within 0.5 volts of battery voltage. With knife blade removed, voltmeter should read between 0 and 0.5 volts.

IGNITION SYSTEM CHECK

NOTE – *Before making the following tests, secure spark tester. If tachometer is connected to ignition coil "TACH" terminal, disconnect it before performing tests. Use a digital voltmeter with 10 megohms impedance or larger.*

1) Remove spark plug wire and attach spark tester to wire. Crank engine and check for spark at tester gap. If there is no spark, check a second wire in same manner. If sparks result, ignition system is not at fault. Suspect fuel system or spark plugs.

2) If no spark resulted in step **1)**, disconnect 4-wire EST connector between distributor and ECM. Crank engine and recheck for spark at tester cap. If spark occurs with EST connector disconnected, proceed to EST System Check.

3) If no spark occurred in step **2)** with 4-wire connector disconnected, check voltage at battery terminal of ignition coil (integral with distributor on most models). Attach positive voltmeter lead to battery terminal and negative lead to ground. Check for voltage while cranking engine.

4) If reading is less than 7 volts, repair primary circuit back to ignition switch. If 7 volts or more, move positive voltmeter lead from battery terminal to "TACH" terminal. Leave negative lead grounded.

5) If reading is under 1 volt, ignition coil connection or ignition coil is defective. Repair or replace as necessary. If 10 volts or more is registered on voltmeter, proceed to step **7)**.

6) If voltage reading on "TACH" terminal was 1-10 volts, replace distributor HEI-EST module and check for spark, following procedure outlined in steps **7)**, **9)**, and **11)**. However, if a spark results in step **11)**, ignition system is OK following module replacement. If there is still no spark, replace ignition coil also, as it too is defective.

7) If in step **5)**, 10 volts or more were read on "TACH" terminal, attach spark tester to coil output terminal (inside distributor cap on some models, with cap still connected to distributor by wiring harness). Crank engine and check for spark.

8) If spark occurs, check color match of pick-up coil connector and ignition coil lead (see note). Inspect cap for water, cracks or other damage. If OK, replace rotor.

NOTE – *Ignition coils with red and white leads (231" engine) should be matched with pick-up coils having either a clear, a black, or a blue connector. Ignition coils with red and yellow leads (except 231" engine) must be matched with pick-up coils with a yellow connector.*

9) If no spark occurred in step **7)**, remove pick-up coil leads from module. Connect positive lead of voltmeter to coil "TACH" terminal and negative lead to ground. Turn ignition switch "ON". For no more than 5 seconds, connect test lamp from battery positive supply to EST-HEI module terminal "P". Watch voltmeter as test lamp touches terminal.

10) If voltage does not drop, check module ground screw. Also check for open in wires from distributor cap (coil) to distributor. If OK, replace HEI-EST module.

11) If voltage dropped, check for spark at tester gap (still attached to coil output terminal) when test light is removed from module terminal. If spark occurred, either pick-up coil or its connections are defective. Perform Distributor Pick-Up Coil Short and Resistance Check if not done previously. Resistance should be 500-1500 ohms.

12) If distributor module tester is available, check HEI-EST module. If OK, check ignition coil ground. If OK, replace ignition coil. If module is defective, replace. If no module tester is available, check ignition coil ground circuit. If OK, replace ignition coil and repeat steps **7)**, **9)**, and **11)**. If spark results, system is OK. If no spark results, original ignition coil is OK. Reinstall coil and replace HEI-EST module.

INTERMITTENT OPERATION CHECK

1) Connect spark tester to 2 different spark plug wires. If no spark, perform Ignition System Check. If spark on either or both wires, check for dwell increase from low to high RPM.

2) Check pick-up coil and Hall Effect switch (if equipped). Replace, if faulty. If pick-up coil and Hall Effect switch are good and dwell did not increase, replace HEI-EST module. If good, but dwell did increase, check fuel system spark plug wires, distributor cap and plugs.

EST EMISSION SYSTEM CHECK

1) With shift lever in "P" (auto. trans.) or Neutral (man. trans.), run engine at fast idle and note timing change as test terminal is grounded. If timing changes, system is operating properly.

2) If timing does not change on vehicles equipped with manual transmissions, proceed to step **3)**. If timing changes on vehicles equipped with automatic transmission, let engine return to idle and place transmission in "D". Note timing change as test terminal is grounded. If timing changes, system is operating properly.

3) If no change in timing occurs (all models), check voltage at output of MAP (Manifold Absolute Pressure) sensor or vacuum sensor as vacuum hose is removed and reinstalled. If no change occurs, problem is in the vacuum or MAP sensor circuit. If voltage output changes, proceed to next step.

4) Disconnect park/neutral switch and recheck for timing change. If timing changes, problem is either an improperly adjusted or faulty park/neutral switch. If timing does not change, check for grounded wire from terminal "H" of ECM to park/neutral switch. If wire is not grounded, replace ECM.

DELCO-REMY ELECTRONIC SPARK TIMING (EST) IGNITION SYSTEM (Cont.)

BY-PASS OR FAULTY EST CHECK

1) With engine at fast idle, check timing. Ground test terminal and note if timing changes. If timing does change, system is operating properly. If timing does not change, stop engine and disconnect 4-wire EST connector from distributor.

2) Connect a jumper wire from terminal "A" to "B" on distributor side of EST connector. Start engine, ground test terminal and connect test light from battery positive terminal to terminal "C" of EST connector. *See Fig. 11.*

3) If engine stops, check for open wire from EST terminal "E" to ECM. If wire is OK, replace either HEI-EST connector or module. If engine runs, remove jumper wire from terminals "A" and "B" while leaving test light connected. If engine runs, proceed to next step. If engine stops, proceed to step **5)**.

4) If engine continued to run in step **3)**, check distributor wires for open or ground to module terminal "B" or short between module terminals "R" and "E". If wires are OK, repair faulty distributor module connection or replace distributor module.

5) If engine stopped in step **3)**, check for open wire from EST connector terminal "A" to ECM connector terminal "12". Also check for open or grounded wire from EST connector terminal "C" to ECM connector terminal "11". If wires are OK, replace faulty ECM connector or ECM.

NOTE – *ECM connector terminal numbers may vary between models.*

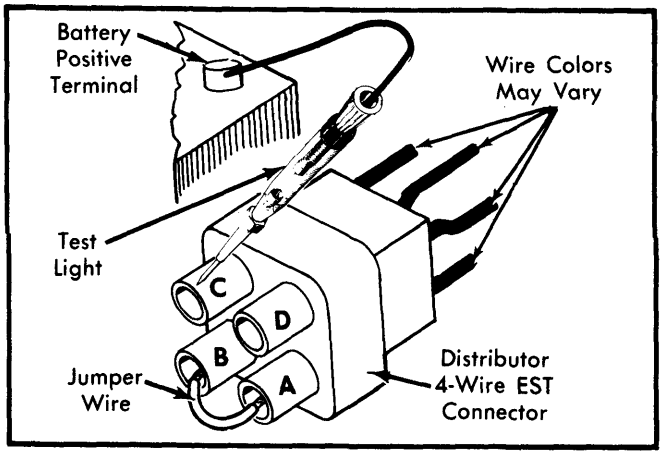

Fig. 11 Test Light Hook-Up for Checking EST Emission System

ESC SYSTEM CHECK

NOTE – *For HEI-EST systems with Electronic Spark Control (ESC), perform steps* **1)** *through* **4)** *of EST Emission System Check prior to beginning these tests.*

1) If complaint is "No Timing Change", proceed to step **4)**. If complaint is "Failure to Start", turn ignition switch "ON". Attach positive lead of voltmeter to terminal "F" of ESC controller, with negative lead touching terminal "K" of controller. *See Fig. 4.* If reading is under 10 volts, check for open condition from terminal "K" to ground and from terminal "F" to battery supply. Also check fuses.

2) If reading was over 10 volts, install a jumper wire between terminals "J" and "G" on ESC controller. Reconnect 4-wire EST connector and try to start the engine.

3) If engine starts, replace either defective ESC controller or its connector. If engine still will not start, check for open condition from ECM terminal "U" to ground. Also check for open or grounded wire to ECM terminal "12". If wires are OK, replace defective ECM or its connector.

4) If complaint was "No Timing Change", install a jumper wire between ESC controller terminals "C" and "D". Place shift lever in "P" (auto. trans.) or Neutral (man. trans.) and run engine at fast idle speed. Check for timing change as 4-wire EST connector is disconnected. If timing changes, replace faulty ESC controller or its connector. If there is no change, check for the presence of a Park-Neutral switch.

5) If there is no Park-Neutral switch, check for open condition in wire from ECM terminal "11" to EST connector terminal "C". If wire is OK, replace defective ECM or its connector.

6) If vehicle has a Park-Neutral switch, disconnect it and recheck timing change as outlined in step **4)**. If change occurs, replace defective Park-Neutral switch or adjust it properly. If no timing change takes place, check for grounded wire from ECM terminal "H" to Park-Neutral switch. Check for open wire from ECM terminal "11" to EST connector terminal "C". If wire is OK, replace defective ECM or its connector.

ESC PERFORMANCE CHECK

NOTE – *Perform these checks only after checking other causes of engine detonation, such as ignition timing, lack of EGR, or engine temperature.*

1) Connect tachometer to engine and run at fast idle speed (about 1500 RPM). Place shift lever "P" (auto. trans.) or Neutral (man. trans.). With engine at normal operating temperature, tap engine block in area of detonation sensor. If engine RPM drops, system is operating properly.

2) If RPM did not drop, disconnect ESC controller and check for RPM change. If no change in RPM, proceed to step **4)**. If RPM drops, turn ignition switch "OFF" and check resistance between ESC harness connector pins "B" and "K". Resistance should be 175-375 ohms. If resistance is OK, replace ESC harness connector or ESC controller.

3) If resistance was not OK, check for open circuit from ESC connector pin "K" to ground. If no open circuit exists, check resistance of detonation sensor. Resistance should be 175-375 ohms. If not, replace detonation sensor. If OK, repair faulty connection, open or ground in wire from detonation sensor to ESC terminal "B".

4) If no change in RPM in step **2)**, note "CHECK ENGINE" light. If light is on, problem is most likely a faulty ESC controller, but also check detonation sensor. If light is off, turn ignition switch "ON" (engine not running) and check voltage from ground to ESC terminal "J".

5) If voltage is under 2 volts, replace ECM. If voltage is over 2 volts, repair short in wire from ESC terminal "J" to ECM terminal "L".

DELCO-REMY ELECTRONIC SPARK TIMING (EST) IGNITION SYSTEM (Cont.)

OVERHAUL

Disassembly – **1)** On distributors with integral ignition coils, detach 4-wire EST connector and wiring connector from cap and turn 4 latches. Remove cap and coil assembly from lower housing. To remove coil, remove coil cover attaching screws, cover, and coil attaching screws. Lift coil with leads from cap.

2) Remove coil arc seal and clean cap with soft cloth, checking for cracks or other damage.

3) On vehicles with external coils, remove coil connector and disconnect 4-wire EST connector. Turn 2 latches and lift off distributor cap.

4) On all models, remove rotor and disconnect pick-up coil leads from HEI-EST module. *See Fig. 1.* Remove Hall Effect switch (if equipped) by removing 2 attaching screws. Mark distributor shaft and gear for later reassembly. Drive out roll pin and remove distributor shaft.

5) On models with integral coil, remove magnetic shield. Then remove retaining "C" washer, pick-up coil, magnet and pole piece. Remove 2 module attaching screws and capacitor screw. Lift module, capacitor and harness assembly from distributor housing. Disconnect wiring harness from module.

Reassembly – Assemble in reverse order, noting the following. Wipe distributor housing and module clean and apply silicone grease between module and housing. Spin shaft to be sure timer core external teeth do not strike pole piece internal teeth.