DELCO-REMY ELECTRONIC SPARK TIMING (EST) IGNITION SYSTEM

General Motors
Buick
Cadillac
Chevrolet (Exc. 229" V6)
Oldsmobile
Pontiac

NOTE – *The Delco-Remy High Energy Ignition System with Electronic Spark Timing (HEI-EST) is used with minor variations on practically all General Motors models. Some Chevrolet 229" VIN K engines are equipped with Electronic Module Retard (EMR). Some EST-equipped engines, such as the 3.8L VIN 3, 4.1L VIN 4, and 4.9L VIN W and T also utilize Electronic Spark Control (ESC) to control detonation. See Fig. 3.*

DESCRIPTION

The Delco-Remy HEI-EST system, a part of most General Motors Computer Command Control Systems, is designed to provide optimum engine 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 *Fig. 1*. It contains a 7-terminal HEI-EST control module, which is not interchangeable with other HEI systems. The distributor also contains a timer core, pick-up coil, radio noise suppression capacitor and, on most models, an internally mounted ignition coil, located under the distributor cap's coil cover.

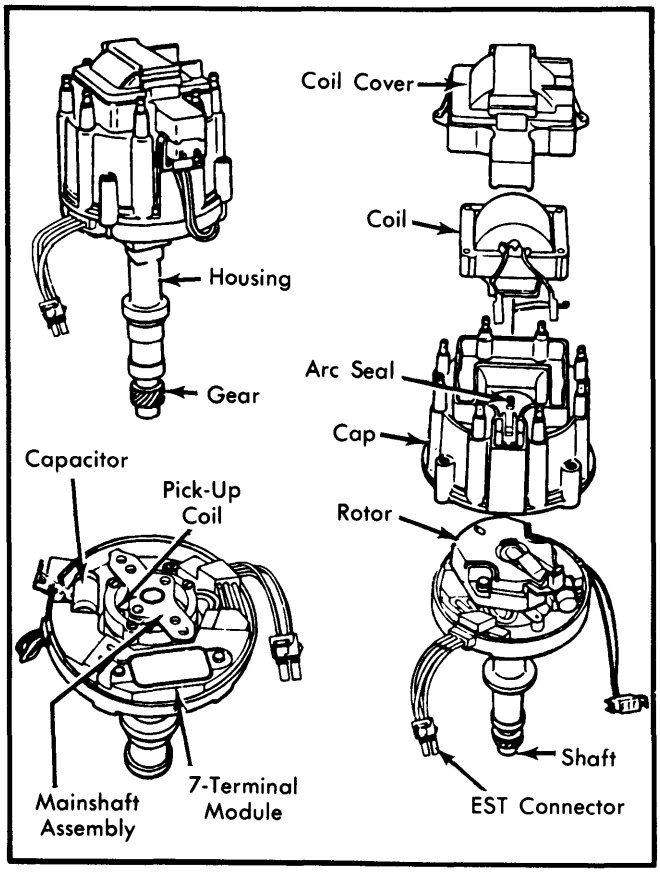

Fig. 1 Disassembled View of EST Distributor (Model with Integral Coil Shown)

NOTE – *On Chevette models with the 1.6L engine and all models with the 2.5L engine, an externally-mounted ignition coil is used.*

The distributor is connected to the EST system by means of a 4-wire terminal, leading to the external electronic control module (ECM). The ECM (not the distributor 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.

The ECM reads all voltage input signals and then provides output signals to the mixture control solenoid in the carburetor to adjust air/fuel ratio or to the distributor to control spark timing and dwell.

CAUTION – *Few components are interchangeable between HEI and HEI-EST distributors. 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 "+" terminal, the coil's "TACH" or negative terminal to the "C" terminal. See *Fig. 2*. 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 connector "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.

In addition to normal HEI-EST system, some engines use an additional electronic spark control (ESC) system to retard spark advance when detonation occurs. The retard mode is held for 20 seconds and then reverts back to the EST system.

There are 3 basic components of the ESC system: A detonation sensor, an HEI-EST distributor, and an ESC Controller. See *Fig. 3*. The sensor sends an electrical signal to the controller terminal "B" in event of detonation. Failure of the sensor would permit no retard. The controller modifies the ECM's EST signal, based on the sensor signal, and sends a command signal from terminal "J" to the HEI-EST module's terminal "E" to adjust spark timing. Constant monitoring of detonation occurs. The ESC controller has no memory function, and failure would result in no ignition, no retard or full retard.

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. 2*. 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.

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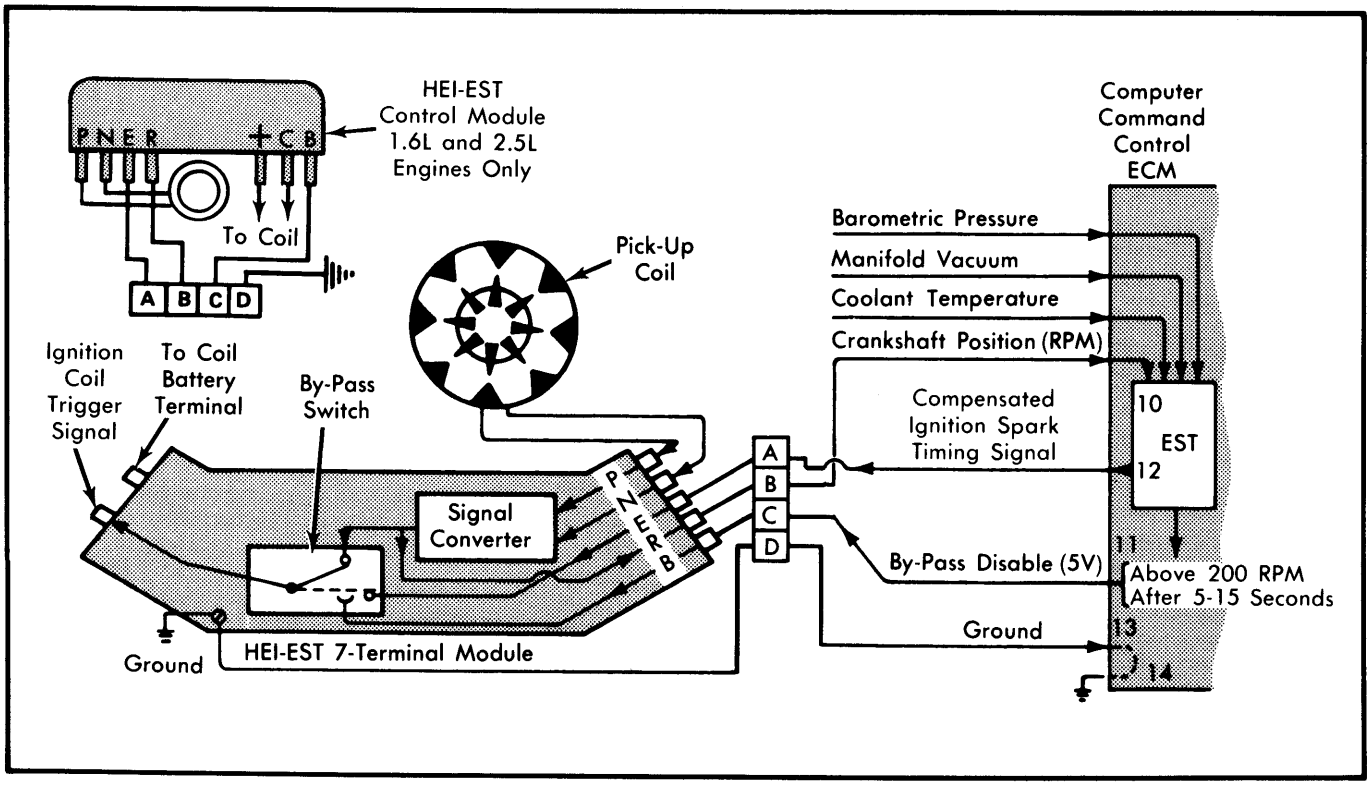

Fig. 2 Schematic of HEI-EST Ignition System Including Relationship To Computer Command Control Electronic Control Module

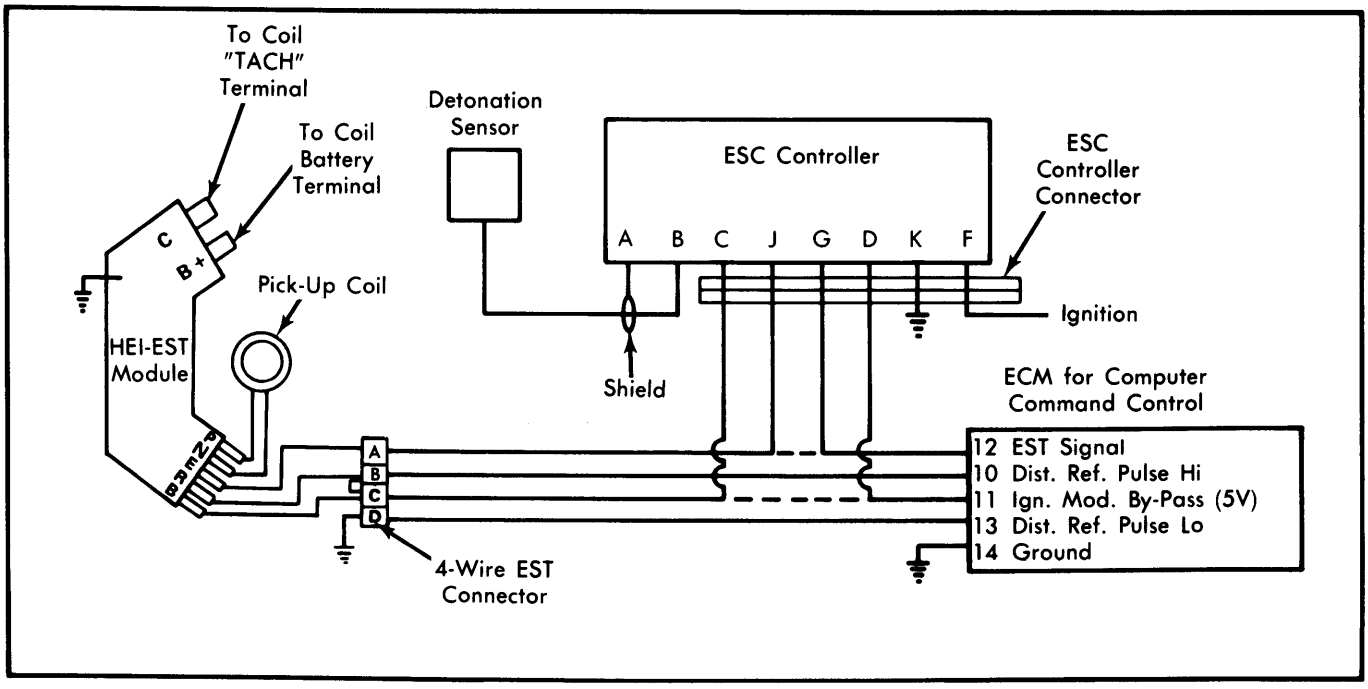

Fig. 3 Schematic of HEI-EST System With Electronic Spark Control (ESC)

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

When engine speed reaches 200 or more RPM (about 5-15 seconds after starting), the ECM transmits a constant 5-volt by-pass signal to the HEI-EST module, changing the position of the by-pass switch. Pick-up coil RPM signals are then converted in the HEI-EST module, but they are now routed, not through the by-pass switch, but out terminal "R" to ECM terminal 10.

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 a low scale, connect ohmmeter leads to battery and "TACH" terminals. *See Fig. 4.* Resistance should be 0-2 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.

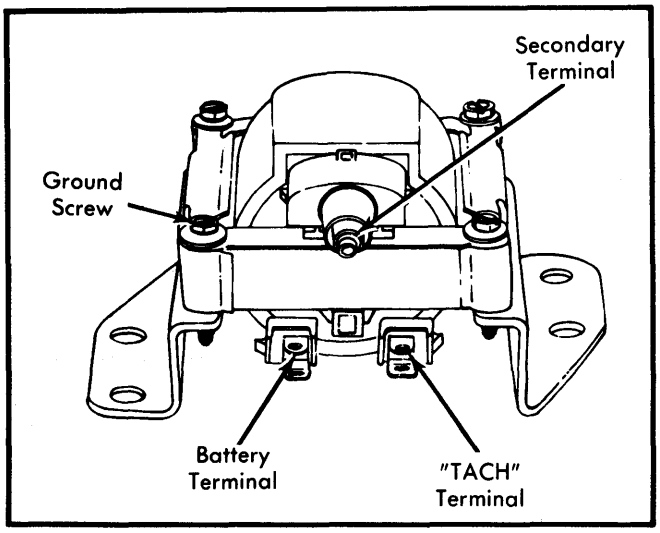

Fig. 4 Ignition Coil Resistance Test Points (External Type Coil)

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. 5.* Set ohmmeter in low scale. Connect ohmmeter leads to battery and "TACH" terminals. Resistance should be 0-2 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.

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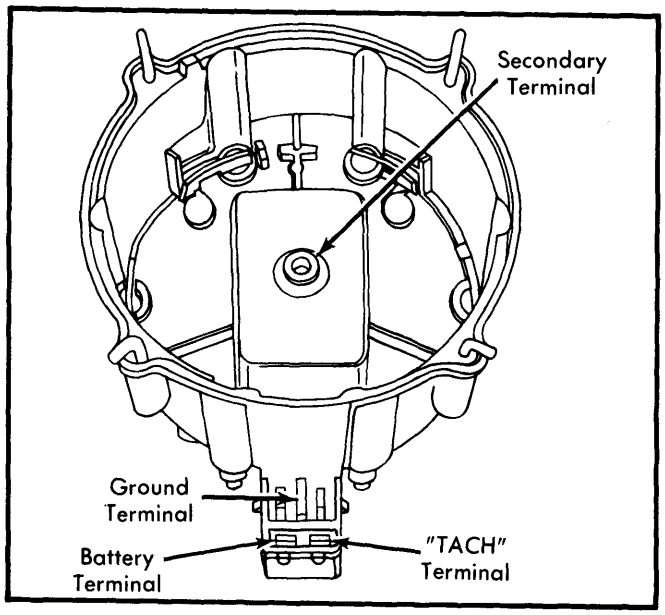

Fig. 5 Ignition Coil Resistance Test Points (Integral Type Coil)

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 to middle range. Connect one lead to either pick-up coil lead and other lead to distributor housing. *See Figs. 6 and 7.* Reading should be infinite. If not, replace pick-up coil.

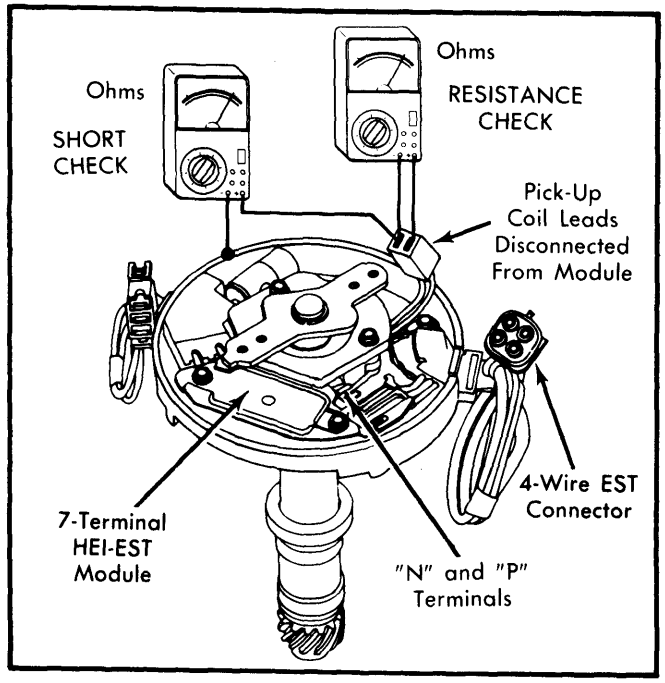

Fig. 6 Distributor Pick-Up Coil Short and Resistance Checks (Integral Coil)

2) Connect ohmmeter leads to each pick-up coil lead, while flexing wires and connectors to locate intermittent opens. *See Figs. 6 and 7.* Resistance should read a constant unchanging value between 500 and 1500 ohms. If not, replace pick-up coil.

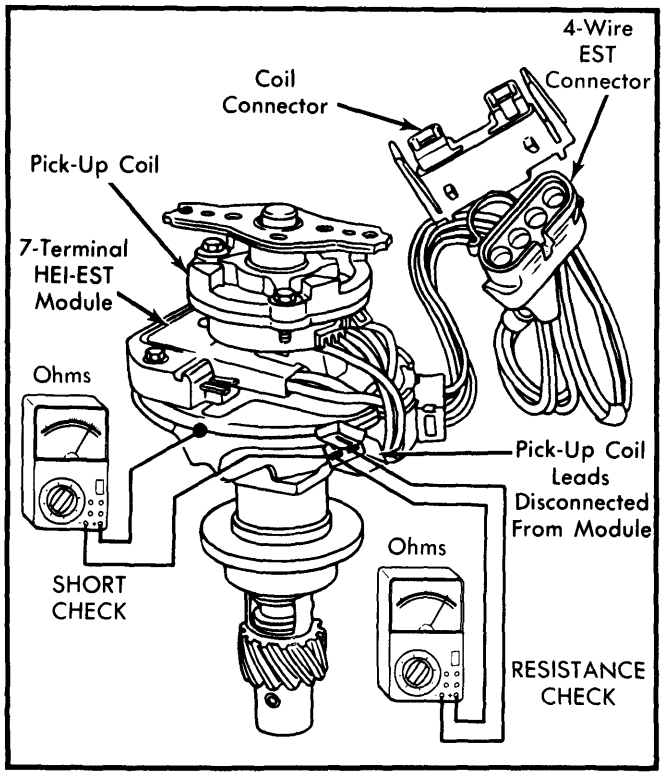

Fig. 7 Distributor Pick-Up Coil Short and Resistance Checks (External Coil)

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 vehicle is equipped with an HEI system other than EST, proceed to step **3)**. If no spark resulted in step **1)** on EST-equipped vehicle, disconnect 4-wire EST connector between distributor and ECM. Crank engine and recheck for spark at tester gap. If spark occurs with EST connector disconnected, proceed to EST System Check.

3) If no spark occurred in step **2)** (with either a Non-EST vehicle or an EST-equipped vehicle 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. Turn ignition switch "ON".

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.

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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.

NOTE – *On vehicles with EMR systems, touch test light to module terminal "H". If this procedure is used for models prior to 1981, touch test lamp to terminal "G" of HEI 4-terminal modules or terminal "D" of 5-terminal ESS or ESC modules.*

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, proceed to Ignition System Check. If spark on either or both wires, check for dwell increase from low to high RPM.

2) Check pick-up coil with ohmmeter. Replace if faulty. If pick-up coil is 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) If car will not run with distributor connected to EST electronic control module (ECM), leave 4-wire EST connector disconnected at distributor and proceed to step **5)**.

2) If car will run with distributor connected to ECM, place shift lever in "PARK" or "NEUTRAL" position. Run engine at fast idle and note timing change as distributor EST connector is disconnected. If timing changes, system is OK.

3) If no timing change takes place on vehicles with automatic transmissions, allow engine to idle in "DRIVE" position. Note timing change as 4-wire EST connector is reconnected and then disconnected. If change occurs, system is OK. If no change occurs proceed to step **4)**.

4) If vehicle is equipped with manual transmission and no change occurred in step **2)**, or if equipped with automatic transmission and no change took place in step **3)**, allow engine to idle. Check voltage output of MAP or vacuum sensor as vacuum hoses are disconnected and reconnected. If no change occurs, problem is in the vacuum or MAP sensor circuit. If voltage output changes, proceed to next step.

5) Stop engine and connect a jumper wire from terminal "A" to terminal "B" of distributor side of EST connector. See *Fig. 8*. Start engine, ground "diagnostic test terminal", and connect test light from battery positive terminal to terminal "C" of 4-wire EST connector at distributor.

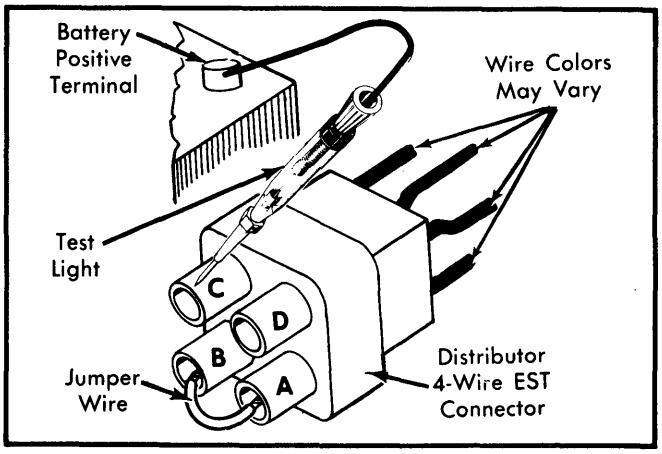

Fig. 8 Test Light Hookup for Checking EST Emission System

6) If engine stops, check for open or grounded distributor wire to terminal "A" of EST connector. If wire is OK, replace faulty HEI-EST module or its connectors. If engine runs in step **5)**, remove jumper wire between terminals "A" and "B" of EST connector.

7) If engine still runs, check distributor wires for open to HEI-EST module terminal "B". Also check for short between module terminals "R" and "E". If wires are OK, replace faulty HEI-EST module or connectors.

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8) If engine stopped when jumper wire was removed from terminals "A" and "B" of EST connector, remove test light and reconnect distributor to EST system. If EST system is also equipped with electronic spark control (ESC), proceed to ESC System Check.

9) If the vehicle is equipped with a straight HEI-EST system (without ESC), and if the complaint is that the car will not start and run with distributor connected to ECM, check for open condition from ECM terminal "U" to ground. Also check for grounded wire to ECM terminal "12" (from HEI-EST module terminal "E" to EST connector terminal "A" to ECM terminal "12"). If wire is OK, replace faulty ECM or ECM connector.

10) If the vehicle is equipped with a straight HEI-EST system and the complaint is "No Timing Change", check for a Park-Neutral switch that signals ECM when vehicle is in "PARK" (auto. trans.) or "NEUTRAL" (man. trans.) shift position. If none, check for open from ECM terminal "11" to EST connector terminal "C". If wire is OK, replace faulty ECM or ECM connector.

11) If vehicle has Park-Neutral switch, disconnect it and recheck for timing change as in step **2)**. If timing now changes, adjust or replace faulty Park-Neutral switch. If no timing change takes place, check for grounded wire from ECM terminal "H" to Park-Neutral Switch.

ESC SYSTEM CHECK

NOTE – *For HEI-EST systems with electronic spark control (ESC), perform steps* **1)** through **8)** 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. 3*. 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 "PARK" or "NEUTRAL" 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 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) Run engine at fast idle speed and place shift lever in "PARK" (auto. trans.) or "NEUTRAL" (man. trans.). Note timing change as exhaust manifold is tapped with a plastic hammer. If timing is retarded, system is operating properly.

2) If timing is not retarded, disconnect detonation sensor. Connect a jumper to detonation sensor connector terminal, forming jumper into a loop on top of distributor (or hold it along a spark plug wire). Note timing.

3) If timing is not retarded, reconnect detonation sensor. Disconnect ESC controller connector and attach ohmmeter leads to terminals "B" and "K" of connector. Resistance should be 175-375 ohms. If resistance is OK, replace ESC controller. If not OK, repair ESC harness.

4) If in step **2)**, timing was retarded when jumper loop was placed over distributor, connect ohmmeter leads to detonation sensor. Resistance should read 175-375 ohms. If not, replace sensor.

5) If resistance is correct, reconnect detonation sensor. Disconnect ESC controller connector. Touch ohmmeter leads to terminals "B" and "K" of connector. Resistance should again read 175-375 ohms. If OK, replace sensor. If not OK, check for an open in wires to terminals "B" and "K". If wires are OK, repair sensor connection. If wires are defective, replace or repair harness.

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*. Mark distributor shaft and gear for later reassembly. Drive out roll pin and remove distributor shaft. On models with integral coil, remove magnetic shield. Then remove retaining "C" washer, pick-up coil, magnet and pole piece.

5) Remove 2 module attaching screws and capacitor screw. Lift module, capacitor and harness assembly from 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.