IGNITION SYSTEMS 1G

SECTION INDEX

FOUR-CYLINDER ENGINE IGNITION SYSTEM

GENERAL

The four-cylinder engine High Energy Ignition (HEI) System consists of the battery, the distributor with integral electronic module, the ignition switch, the spark plugs, and the primary and secondary wiring. Refer to Chapter 1D—Batteries for battery information.

HEI SYSTEM COMPONENTS

Distributor

The High Energy Ignition System distributor combines all ignition components into one unit (fig. 1G-1 and 1G-2). The external connections are for the ignition switch, tachometer, and spark plugs. The ignition switch terminal at the distributor has full battery voltage applied when the ignition switch is in the RUN and START positions. There is no ballast resistor or resistance wire between the switch and distributor.

The ignition coil is located in the distributor cap and connects to the rotor through a resistance brush.

The High Energy Ignition System functions basically the same as a conventional ignition system, but the electronic module and pick-up coil replace the contact points.

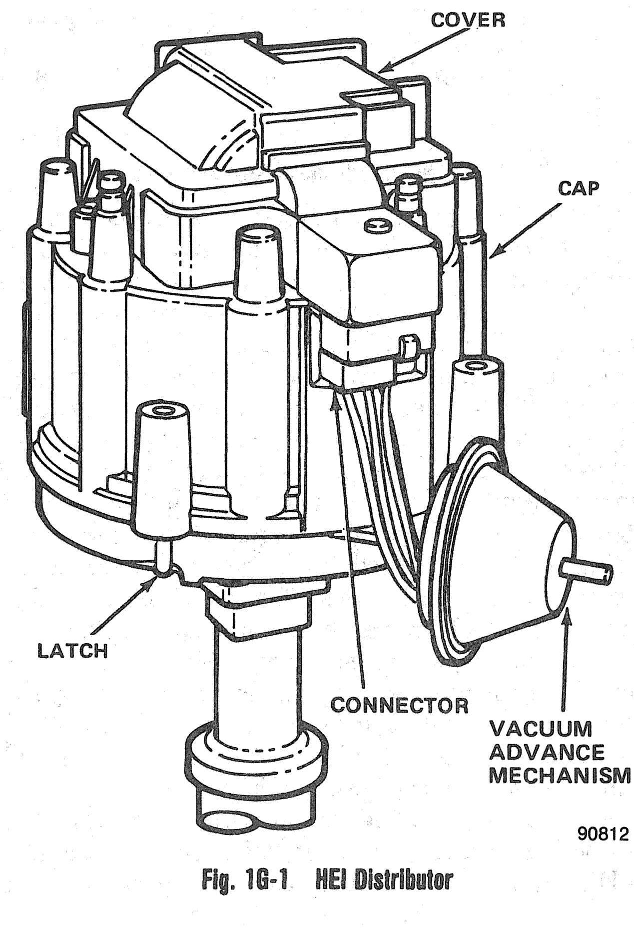

Fig. 1G-1 HEI Distributor

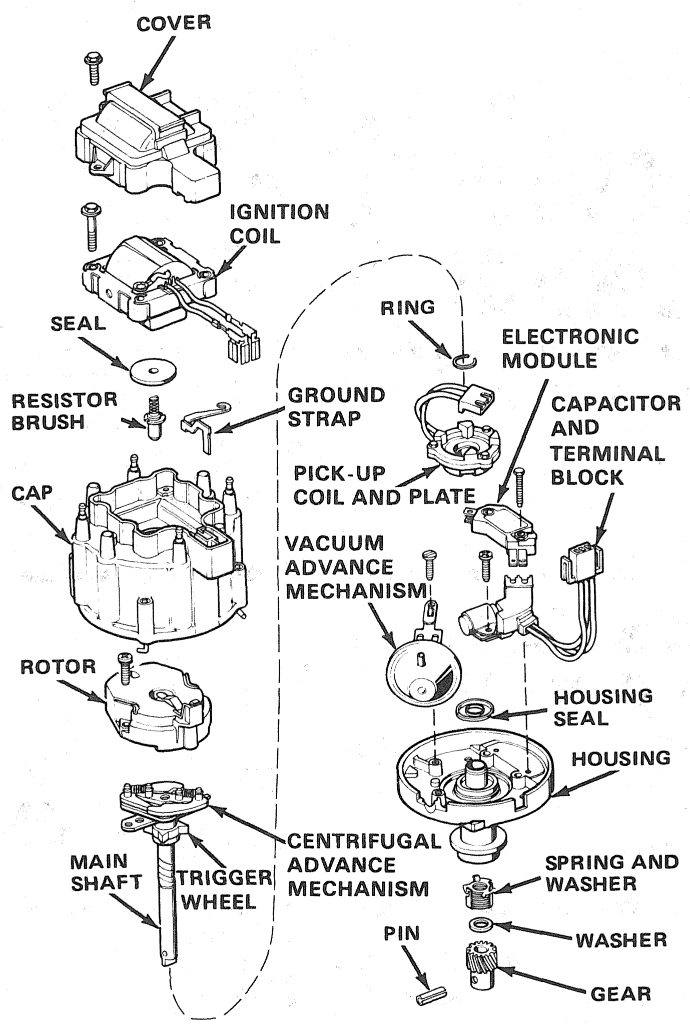

Fig. 1G-2 HEI Distributor—Exploded View

The High Energy Ignition system is a magnetic pulse triggered, transistor controlled, inductive discharge ignition system. The magnetic pick-up assembly located inside the distributor contains a permanent magnet, a pole piece with internal teeth and a pick-up coil. When the teeth of the timer core rotating inside the pole piece line up with the teeth of the pole piece, an induced voltage pulse from the pick-up coil is applied to and amplified by the electronic module to trigger the coil primary circuit. As the primary current decreases, a high voltage is induced in the ignition coil secondary winding, which is applied to the rotor and secondary wires to fire the spark plugs. The capacitor in the distributor is for radio interference noise suppression.

The magnetic pick-up assembly mounted over the main bearing on the distributor housing is shifted by the vacuum control unit to provide vacuum advance. The timer core is shifted about the shaft by conventional advance weights to provide centrifugal advance.

The electronic module automatically controls the dwell period, extending it as engine speed is increased. The HEI system also features a longer spark duration that is made possible by the increased amount of electromagnetic energy stored in the coil primary. This is desirable for igniting lean mixtures.

No periodic lubrication is required. Engine oil lubricates the lower bushing and an oil-filled reservoir provides lubrication for the upper bushing.

NOTE: *When conducting cylinder compression tests, disconnect ignition switch connecting wire (yellow) from HEI system.*

Ignition Timing

Timing specifications are listed in Chapter 1A—General Service and Diagnosis and on the Emission Control Information label located in the engine compartment. When using a timing light, connect an adapter between the No. 1 spark plug and the No. 1 spark plug wire, or use a light with an inductive type pick-up. **Do not pierce the spark plug wire.** Once the insulation of a spark plug wire has been broken, the high voltage will cause arcing to the nearest ground, and the spark plug will not fire properly. Always refer to the Emission Control Information label when adjusting the timing. Refer to figure 1G-3 when loosening the distributor holddown clamp.

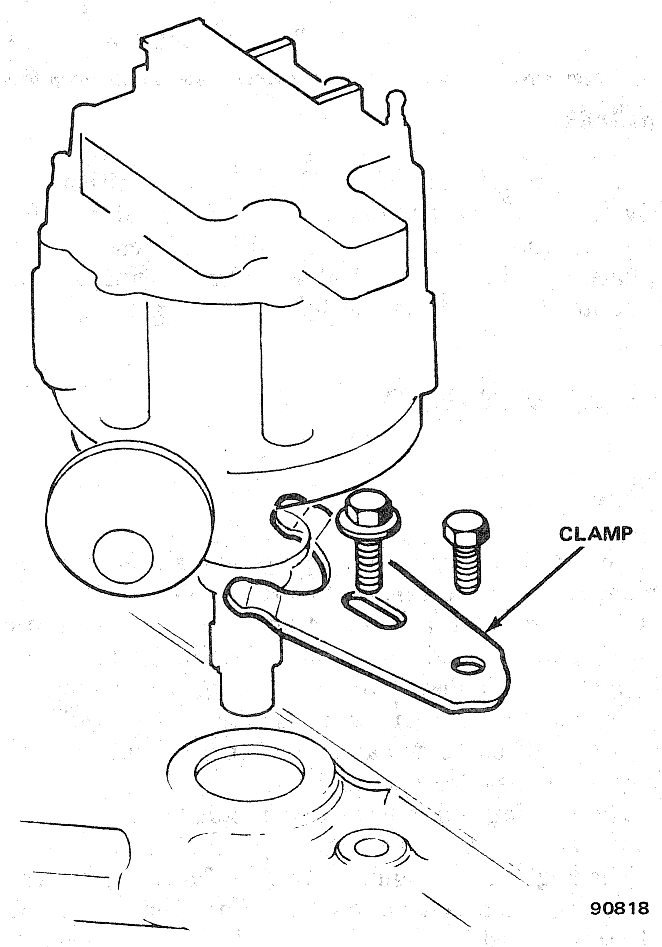

Fig. 1G-3 Distributor Holddown Clamp

A magnetic timing probe socket is located on the timing gear cover for use with special electronic timing equipment. Figure 1G-4 depicts the typical magnetic timing probe socket. Consult the manufacturer's instructions for use of this type equipment.

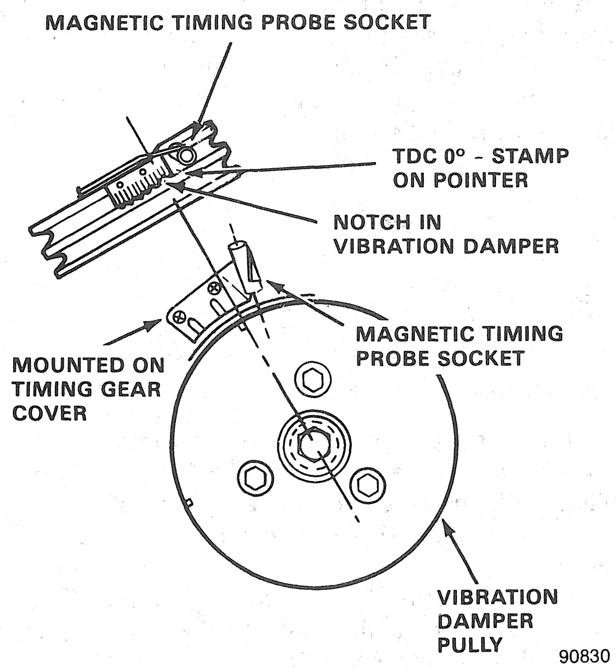

Fig. 1G-4 Magnetic Timing Probe Socket and Timing Degree Scale

Secondary Wiring

The spark plug wiring used with the HEI system is a carbon impregnated cord conductor encased in an 0.3125-inch (8 mm) diameter silicone rubber jacket. The silicone rubber jacket will withstand very high temperatures and also provides an excellent insulator for the higher voltage provided by the HEI system. The silicone rubber spark plug boots form a tight seal around the plug. **The boot should be twisted 1/2 turn before removing.** Care should also be exercised when connecting a timing light or other test equipment. Do not force anything between the boot and wiring or through the silicone rubber jacket. Connections should be made in parallel using an adapter. DO NOT pull on the wire to remove. Pull on the boot or use a tool designed for this purpose.

Spark Plugs

Resistor type, tapered seat spark plugs are used (fig. 1G-5). No gasket is used with tapered seat plugs. Refer to figure 1G-6 for an explanation of the spark plug code.

Refer to the Tune-Up Specifications listed in Chapter 1A for spark plug application and gap sizes. Always replace plugs with the correct plug type listed in the tune-up specifications.

Normal engine operation is usually a combination of idling, slow-speed, and high-speed driving. Occasional

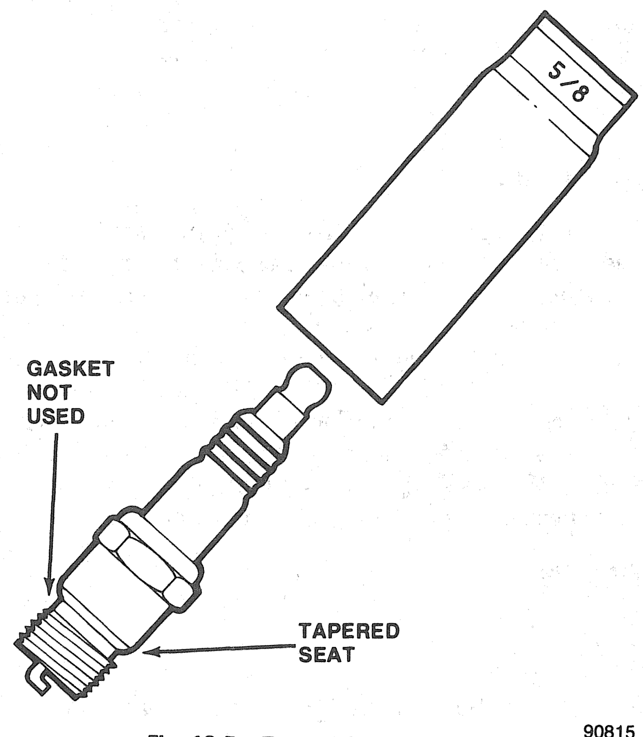

Fig. 1G-5 Tapered Seat Spark Plug

1	2	3	4	5
R	4	4	T S	X

1 — R-INDICATES RESISTOR-TYPE PLUG.
2 — 4-INDICATES 14 mm THREADS.
3 — 4-HEAT RANGE.
4 — T-TAPERED SEAT.
S-EXTENDED TIP
5 — X-SPECIAL GAP.

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Fig. 1G-6 Spark Plug Code

high-speed driving is needed for good spark plug performance because it provides increased combustion heat that burns away deposits of carbon or oxide that have built up from frequent idling or continual stop-and-go driving.

The spark plugs are protected by insulating boots made of special heat-resistant silicone rubber that covers the spark plug terminal and extends downward over a portion of the porcelain insulator. These boots prevent arcing, which causes engine misfire. The dirt film that builds up on the exposed portion of the plug will not cause arcing.

NOTE: *Do not mistake corona discharge for arcing or as the result of a shorted insulator. Corona is a steady blue light haze appearing around the insulator, just above the shell crimp. It is the visible evidence of a high electrostatic voltage field and has no effect on ignition performance. Usually it can be detected only in darkness. This discharge may repel dust particles and leave a clear ring on the insulator just above the shell. This ring* *is sometimes mistakenly regarded as evidence that combustion gases have blown out between shell and insulator.*

Ignition Switch

The mechanical key-controlled ignition switch is located in the steering column on the right-hand side just below the steering wheel. The electrical switching portion of the assembly is separate from the key and lock cylinder and is located on top of the column. Both function together through the action of the actuator rod.

For a complete explanation of the key and lock cylinder, and the actuator rod, refer to Chapter 2H—Steering Column. Refer to Chapter 3R—Lighting Systems for the detailed explanation of the electrical components.

DIAGNOSIS

HEI Distributor

Refer to Ignition System Troubleshooting Chart.

Spark Plugs

Faulty or dirty plugs may perform well at idling speed, but at higher speeds they frequently fail. Faulty plugs are identified in a number of ways: poor fuel economy, power loss, loss of speed, hard starting and, in general, poor engine performance.

Spark plugs may also fail because of carbon fouling, excessive gap, or a broken insulator.

Fouled plugs may be verified by inspecting for black carbon deposits. The black deposits are usually the result of slow-speed driving when sufficient engine operating temperature is seldom reached. Worn pistons and rings, faulty ignition, an over-rich air/fuel mixture and the use of spark plugs with too low of a heat range will also result in carbon deposits.

Excessive gap wear, on plugs with low mileage, indicates that the engine has been operating at high speeds continuously or with loads that are greater than normal, or that plugs that have too high of a heat range are being used. Electrode wear may also be the result of the plug being overheated. This can be caused by combustion gases leaking past the threads because of insufficient tightening of the spark plug. An excessively lean air/fuel mixture will also result in abnormal electrode wear.

A broken lower insulator is usually the result of improper installation or carelessness when regapping the plug. Broken upper insulators usually result from a poor fitting wrench or an outside blow. A cracked insulator may not be evident immediately, but will as soon as oil or moisture penetrates the crack. The crack will usually be located just below the crimped part of the shell and may not be visible.

Broken lower insulators usually result from carelessness when regapping and are generally visible. This type of break may also result from the plug operating too "hot," which may occur during periods of extended high-speed operation or with heavy engine loads. When regapping a spark plug, always make the gap adjustment by bending the ground (side) electrode. Spark plugs with broken insulators should always be replaced. Spark plugs should be tightened with 15 to 25 foot-pounds (20 to 34 N•m) torque.

ON-VEHICLE SERVICE

HEI Distributor

Precautions and General Information

(1) When performing cylinder compression tests, disconnect ignition switch (BAT) wire at distributor. When disconnecting this connector **do not** use a screwdriver or tool to release locking tab because it may break.

(2) No periodic lubrication is required. Engine oil lubricates lower bushing and oil-filled reservoir provides lubrication for upper bushing.

(3) Tachometer (TACH) terminal is located next to ignition switch (BAT) connector on distributor cap.

CAUTION: *The tachometer terminal must NEVER be connected to ground because damage to the electronic module and/or ignition coil can result.*

NOTE: *Some tachometers currently in use may NOT be compatible with the High Energy Ignition System. Consult the manufacturer of the tachometer if unsure.*

(4) Dwell is controlled by electronic module and cannot be manually adjusted.

(5) Centrifugal advance and vacuum advance mechanisms are similar to those used with conventional ignition systems.

(6) Insulating jacket material used to construct spark plug wires is very soft. It will withstand more heat and higher voltage, but is more susceptible to chafing and cutting. Spark plug wires must be routed correctly to prevent chafing or cutting. Refer to Spark Plug Wires. When removing spark plug wire from spark plug, twist boot on spark plug and pull **on boot** to remove wire, or use special tool designed to remove spark plug boots.

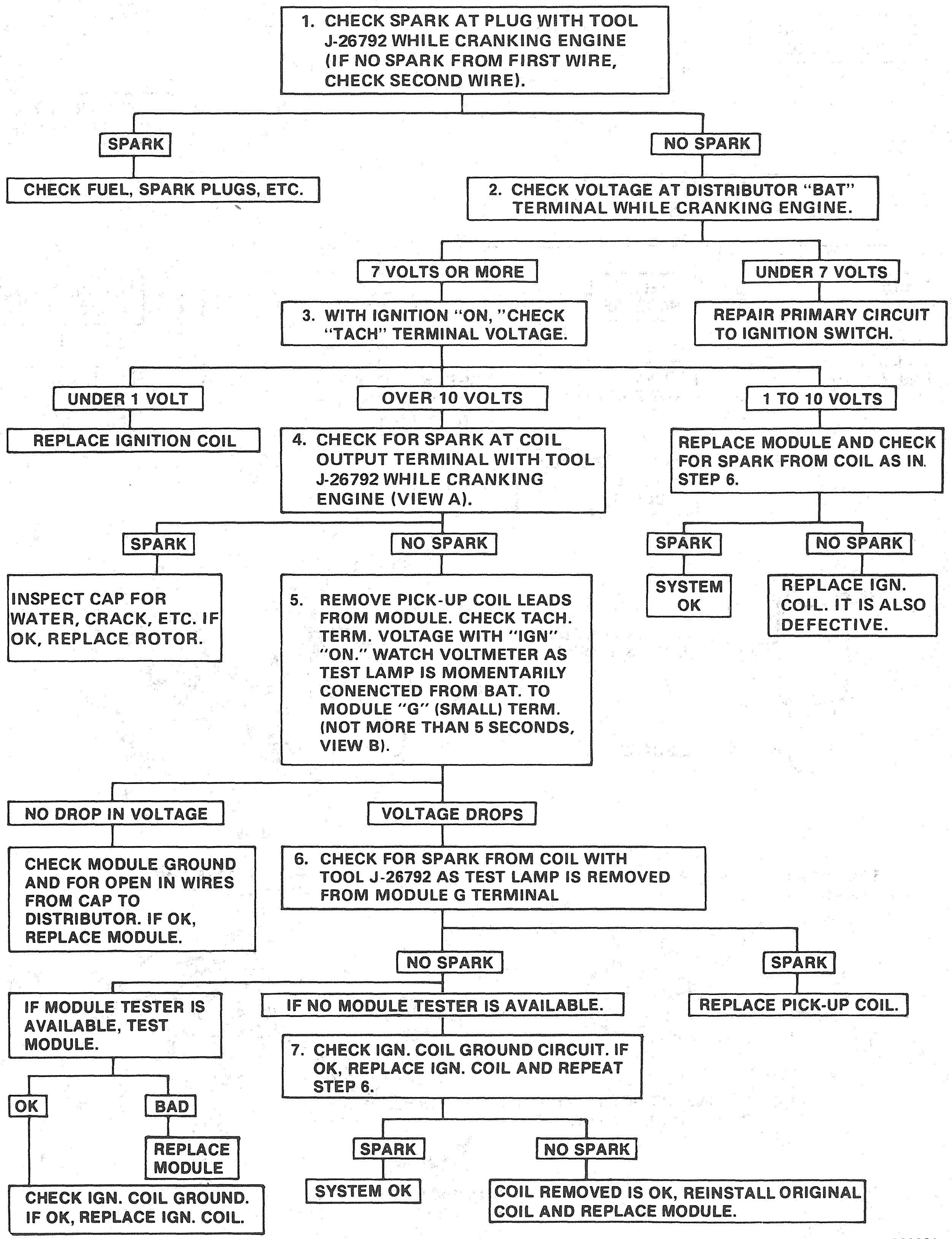
Replacement

(1) Disconnect ignition switch battery wire and tachometer connector, if equipped, from distributor cap. Also, release coil connectors from cap.

Ignition System Troubleshooting

ENGINE CRANKS, BUT WILL NOT START

NOTE: IF A TACHOMETER IS CONNECTED TO THE TACHOMETER TERMINAL, DISCONNECT IT BEFORE PROCEEDING WITH THE TEST.



NOTE: REFER TO VIEWS A AND B FOLLOWING THIS CHART.

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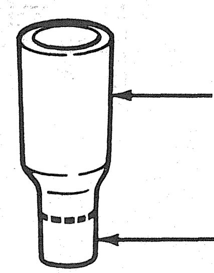
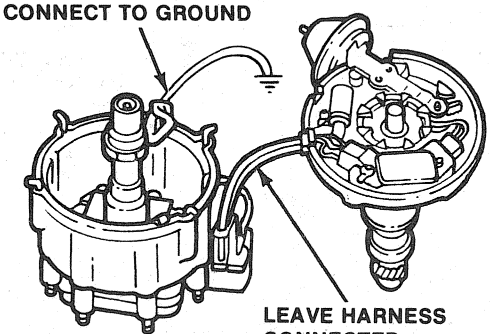
Ignition System Troubleshooting

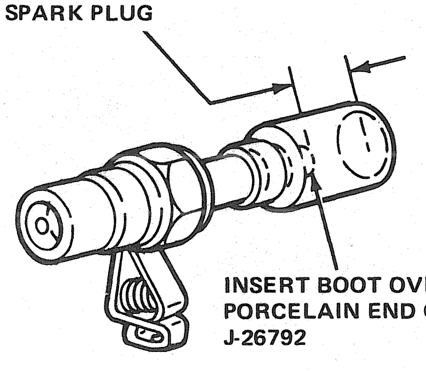
INTERMITTENT OPERATION OR MISFIRE

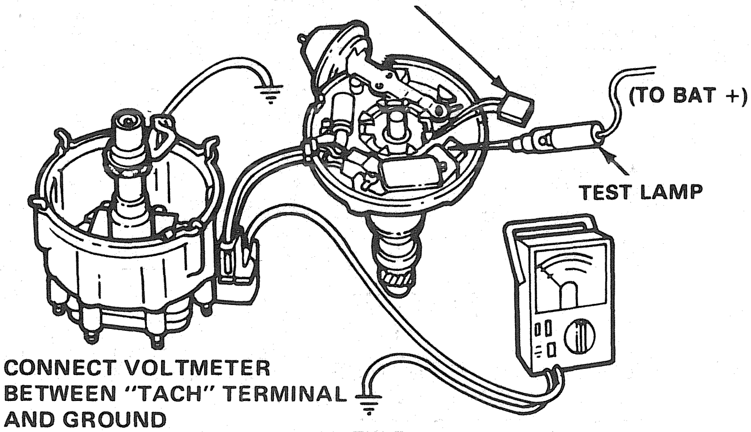
- CHECK SPARK AT TWO PLUG WIRES WITH TOOL J-26792
  - SPARK FROM ONE OR BOTH WIRES
    - CHECK PICK-UP COIL WITH OHMMETER
      - BAD
        - REPLACE
      - GOOD
        - CHECK FOR DWELL INCREASE FROM HIGH TO LOW RPM
          - DWELL INCREASE
            - TROUBLE NOT FOUND
              - CHECK FUEL, PLUG WIRES, CAP AND PLUGS
          - DWELL DID NOT INCREASE
            - REPLACE ELECTRONIC MODULE
  - NO SPARK
    - CONTINUE WITH NO START PROCEDURE





VIEW A





VIEW B

90832B

(2) Remove distributor cap by turning four latches counterclockwise (requires "stubby" screwdriver). Move cap out of way.

(3) Remove vacuum hose from vacuum advance unit.

(4) Remove distributor holddown clamp bolt and clamp (fig. 1G-3).

(5) Note position of rotor, then pull distributor up until rotor stops turning counterclockwise and again note position of rotor.

NOTE: *To ensure correct timing of the distributor, the distributor must be INSTALLED with the rotor correctly positioned as noted above.*

(6) If engine was accidentally cranked after distributor was removed, following procedure can be used for installing distributor:

(a) Remove No. 1 spark plug.

(b) Place finger over No. 1 spark plug hole and crank engine slowly until compression is felt.

(c) Align timing mark on vibration damper at 0° on graduated degree scale on timing gear cover.

(d) Turn rotor to point between No. 1 and No. 3 spark plug towers on distributor cap.

(e) Install distributor cap and spark plug wires.

(f) Install distributor and connect ignition switch wire and tachometer wire, if equipped.

(g) Check engine timing (refer to Ignition Timing).

Rotor

Replacement

(1) Remove distributor cap as described in Distributor Replacement.

(2) Remove rotor. Rotor is retained by two screws and has a slot that fits over square lug on advance weight base so that rotor can be installed in only one position.

Electronic Module

It is not necessary to remove the distributor from the engine to replace the module. Refer to figure 1G-7.

Replacement

(1) Remove distributor cap and rotor.

(2) Remove two module attaching screws and lift module up.

(3) Disconnect two pick-up coil wires from module. (Observe wire colors because they must not be interchanged.) Disconnect harness connector.

(4) Do not wipe grease from module or distributor base if same module is to be installed. If replacement module is to be installed, package of silicone grease will be included with it. Spread grease on metal face of

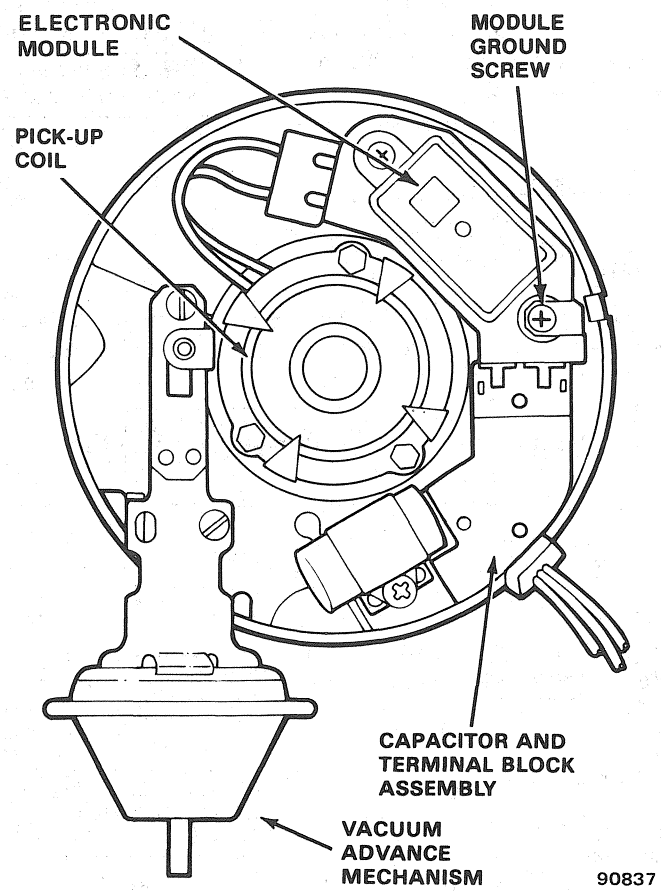


Fig. 1G-7 Distributor Base and Components

module and on distributor base where module seats. This grease is necessary for module cooling.

(5) To install, reverse removal procedure.

Pick-Up Coil

Replacement

(1) Remove distributor from engine. Mark distributor shaft and gear so that they may be reassembled in same position (refer to Distributor Replacement).

(2) Drive out roll pin and remove gear.

(3) Remove distributor shaft with rotor and advance weights.

(4) Remove thin "C" washer on top of pick-up coil assembly, remove pick-up coil wires from module, and remove pick-up coil assembly. Do not remove three screws.

(5) To install, reverse removal procedure. Note alignment marks when installing gear.

Vacuum Advance Unit

Replacement

(1) Remove distributor cap and rotor as previously described.

(2) Remove two vacuum advance unit attaching screws.

(3) Turn pick-up coil clockwise and push rod end of vacuum advance unit down so that it will disengage and clear pick-up coil plate.

(4) To install, reverse removal procedure.

Integral Ignition Coil

Replacement

(1) Release distributor cap as previously described. Remove plug wires, and remove cap from distributor.

(2) Remove three coil cover attaching screws and lift off cover.

(3) Remove four coil attaching screws and lift ignition coil and wires from cap.

(4) To install, reverse removal procedure.

Capacitor

The capacitor is part of the coil wire harness assembly. Because the capacitor is necessary only for radio interference noise suppression, it will seldom need replacement.

Replacement

(1) Remove distributor cap and rotor. Disconnect harness from cap.

(2) Remove capacitor holddown screw and unplug connector from module. For ease of removal, loosen module screws.

(3) To install, reverse procedure above. Ensure attaching screw is inserted through ground tab.

Ignition Timing

(1) Refer to Emission Control Information label located in engine compartment and use specifications listed on label.

(2) With ignition off, connect timing light to No. 1 spark plug. Install jumper wire between spark plug wire and spark plug or use timing light with inductive type pick-up. **DO NOT** pierce spark plug wire or attempt to insert jumper wire between boot and spark plug wire. Connect timing light power terminals according to manufacturer's instructions.

WARNING: *Use extreme caution when engine is operating. Do not stand in direct line with fan. Do not put hands near pulleys, belts or fan. Do not wear loose clothing.*

(3) Start engine and aim timing light at timing degree scale. Index on vibration damper will line up with one timing degree mark. If change is necessary, loosen distributor holddown clamp bolt at base of distributor (fig. 1G-3). While observing scale with timing light, slightly rotate distributor until index aligns with correct timing degree mark. Tighten holddown bolt and recheck timing.

(4) Turn off engine and remove timing light. Reconnect No. 1 spark plug wire, if removed.

Spark Plug Wires

Use care when removing spark plug wire boots from spark plugs. Twist the boot 1/2 turn before removing and pull on the **boot only** to remove the wire.

When replacing spark plug wires, route the wires correctly and secure in the proper retainers. Failure to route the wires properly can cause radio to have ignition noise, crossfiring of the plugs or short circuit the wires to ground.

Refer to figure 1G-8 for correct spark plug wire routing.

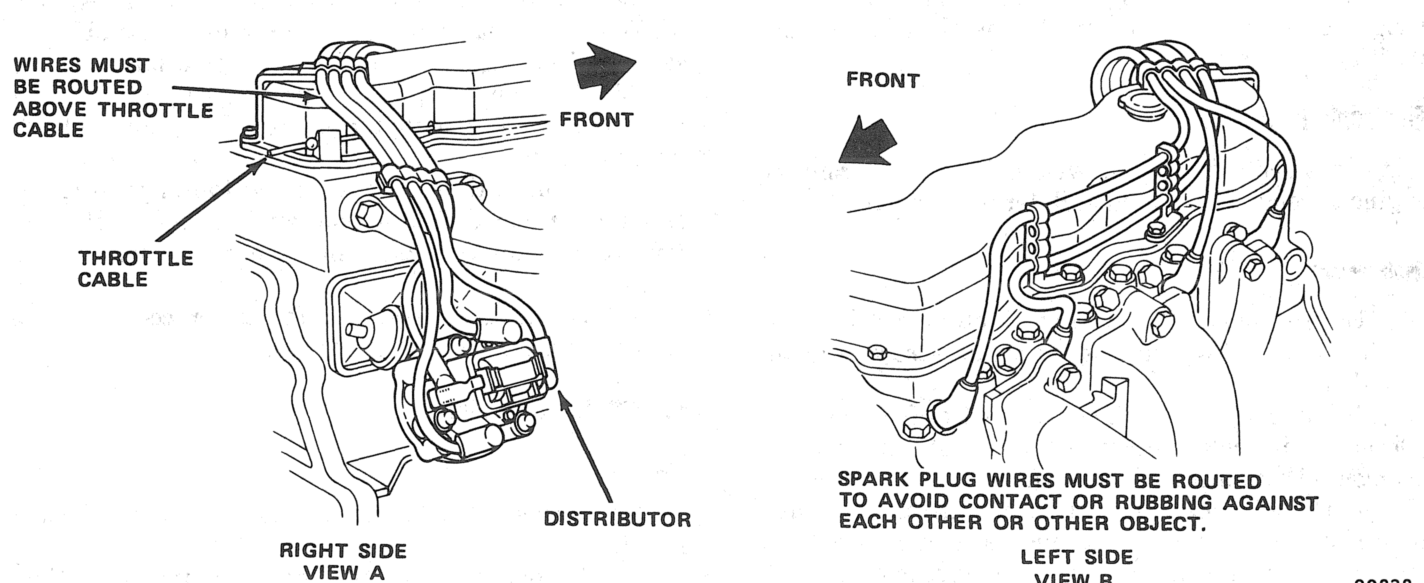
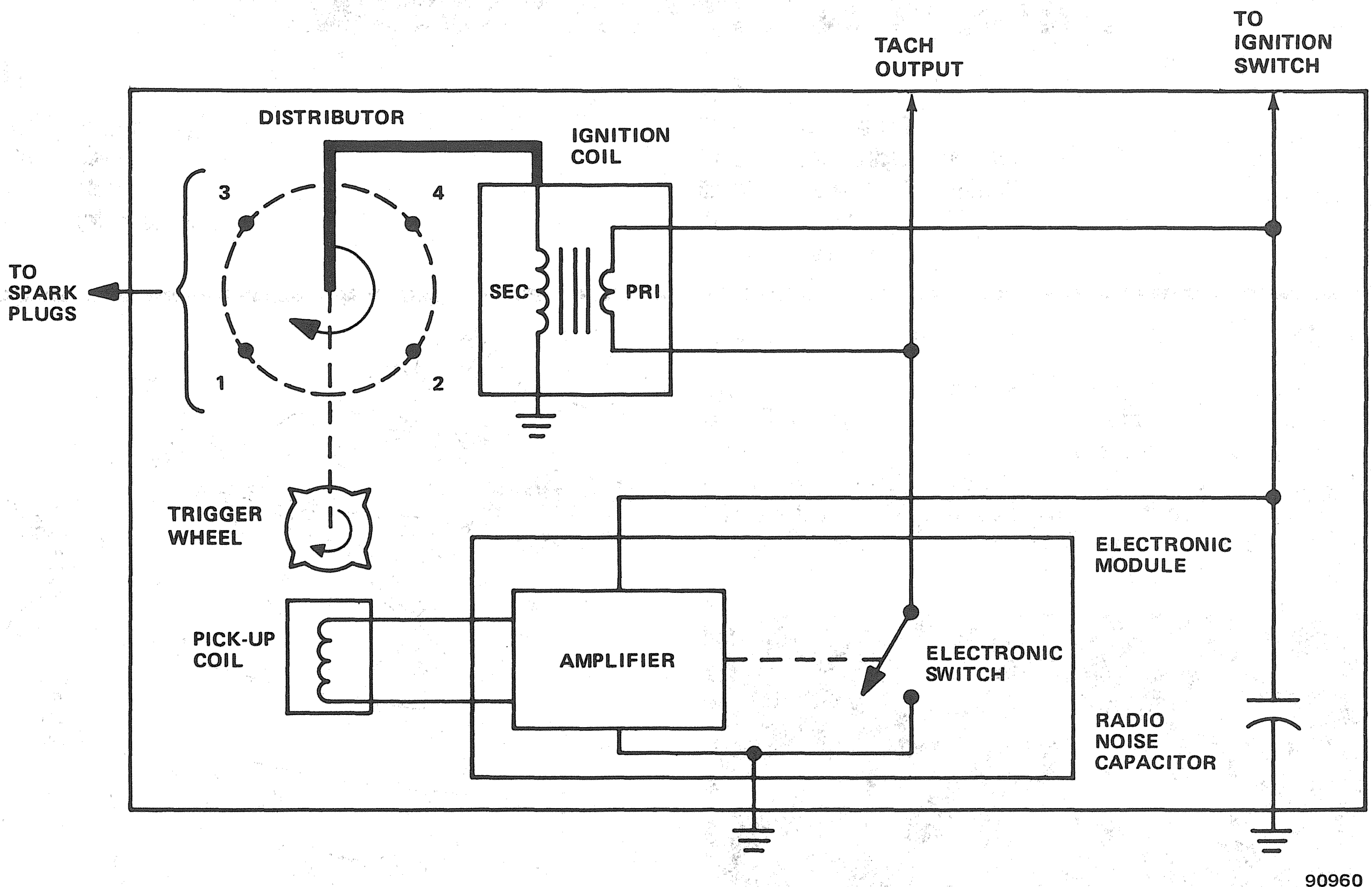


Fig. 1G-8 Spark Plug Wire Routing

SPECIFICATIONS



HEI System Schematic

Distributor and Coil Specifications

Distributor Pick-Up Coil Resistance . . . . .500 to 1500 ohms
Coil
Primary Resistance . . . . .Zero or nearly zero on Low Scale
Secondary Resistance . . . . .Less than infinite on High Scale

81112

Torque Specifications

Service Set-To Torques should be used when assembling components. Service In-Use Recheck Torques should be used for checking a pre-torqued item.

	USA (ft-lbs)		Metric (N·m)	
	Service Set-To Torque	Service In-Use Recheck Torque	Service Set-To Torque	Service In-Use Recheck Torque
Distributor Clamp Screw	17	15-20	23	20-27
Spark Plugs	20	15-25	27	20-34

All Torque values given in foot-pounds and newton-meters with dry fits unless otherwise specified.

81113

SIX- AND EIGHT-CYLINDER ENGINE IGNITION SYSTEM

GENERAL

The Solid State Ignition (SSI) system is used on all six- and eight-cylinder Jeep engines. This system is easily recognizable by the unique coil connector (fig. 1G-9). The electronic ignition control unit is housed in an unpainted metal container that has unique connectors (fig. 1G-10). The distributor also has a metal vacuum spark advance mechanism (fig. 1G-11).

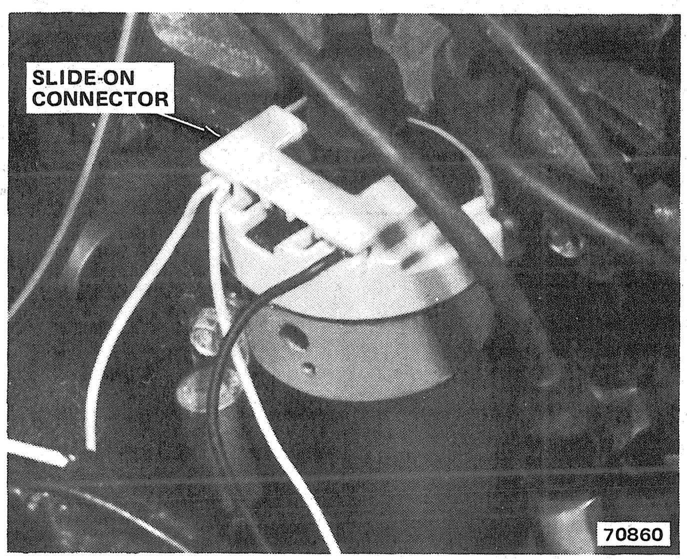


Fig. 1G-9 Coil Connector

COMPONENTS

The SSI system consists of the following major components: ignition switch, electronic ignition control unit, ignition coil, primary resistance wire and bypass, distributor, secondary wires and spark plugs.

NOTE: *When disconnecting SSI system connectors, pull apart with firm, straight pull. Do not attempt to pry apart with a screwdriver. When connecting, press together firmly to overcome hydraulic pressure caused by the grease.*

NOTE: *If connector locking tabs weaken or break off, do not replace associated component. Bind connectors together with tape or harness tie strap to assure good electrical connection.*

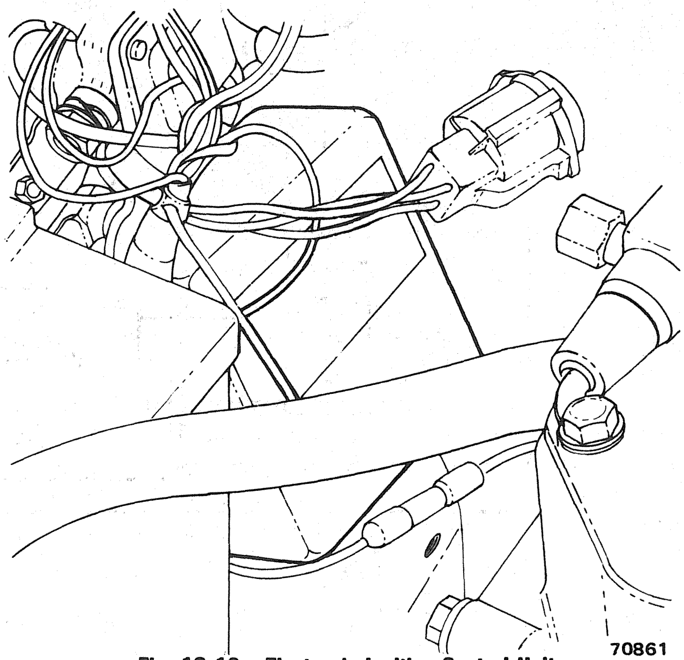


Fig. 1G-10 Electronic Ignition Control Unit

Electronic Ignition Control Unit

The electronic ignition control unit is a solid-state, moisture-resistant module. The component parts are permanently sealed in a potting material to resist vibration and adverse environmental conditions. All connections are weatherproof. The control unit also incorporates reverse polarity and transient voltage protection.

NOTE: *The unit is not repairable and must be replaced as a unit if service is required.*

Ignition Coil

The ignition coil is oil-filled and hermetically sealed (standard construction). The coil has two windings wound on a soft iron core. The primary winding consists of comparatively few turns of heavy gauge wire. The secondary winding consists of many turns of fine gauge wire.

The function of the ignition coil in the SSI system is to transform battery voltage applied to the primary winding to high voltage for the secondary circuit.

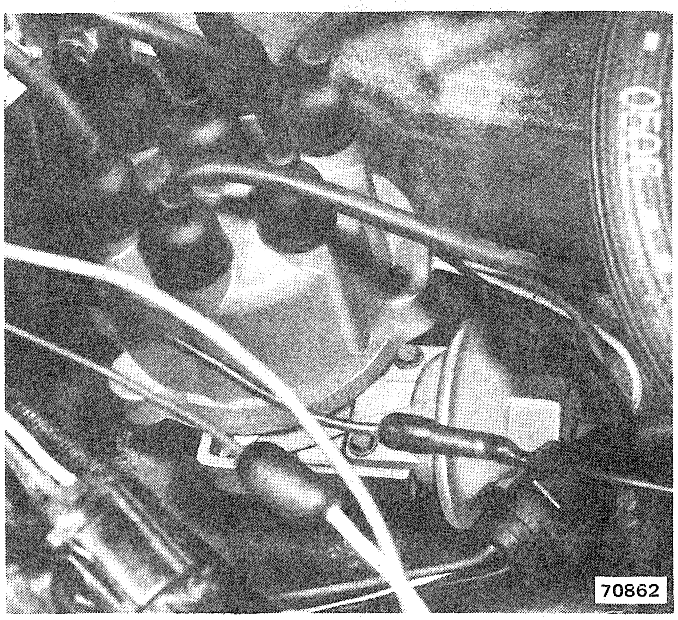


Fig. 1G-11 Distributor Vacuum Spark Advance Mechanism

The ignition coil does not require special service other than maintaining the terminals and connectors clean and tight.

When an ignition coil is suspected of being defective, test it on the vehicle. A coil may break down after the engine has heated it to a high temperature. *It is important that the coil be at operating temperature when tested.* Perform the test according to the test equipment manufacturer's instructions.

Coil Connector

The coil terminals and coil connector are of unique design (fig. 1G-9). The connector is removed from the coil by grasping both sides and pulling connector away from coil (fig. 1G-12).

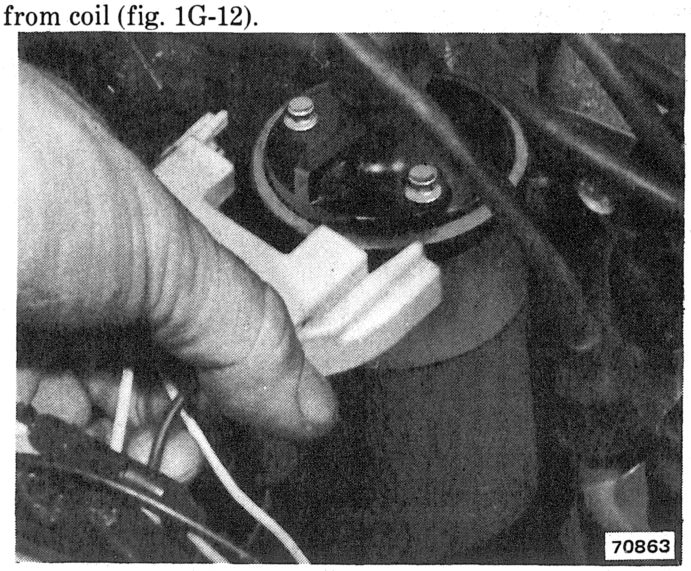


Fig. 1G-12 Removing Coil Connector

When a tachometer is required for engine testing or tune-up, connect it using an alligator jaw type connector as illustrated in figure 1G-13.

Resistance Wire

A wire having 1.35 ± 0.05 ohms resistance is provided in the ignition wiring to supply less than full battery voltage to the coil after the starter motor solenoid is deenergized. During engine starting, the resistance wire is bypassed and full battery voltage is applied to the coil. The bypass is accomplished at the I-terminal on the starter motor solenoid. The bypass switch is energized only while the starter motor circuit is in operation.

Distributor

The distributor consists of three groups of components: pick-up coil and trigger wheel, spark advance assembly, and cap and rotor.

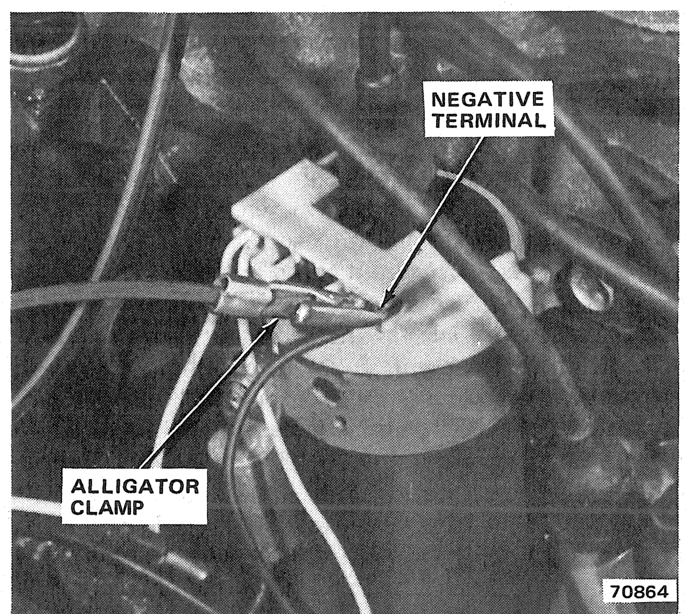


Fig. 1G-13 Tachometer Connection

Pick-up Coil and Trigger Wheel

Current flowing through the ignition coil primary winding creates an electromagnetic field around the primary and secondary windings. When the circuit is opened and current flow stops, the electromagnetic field collapses and induces high voltage into the secondary winding. The circuit is opened and closed electronically by the control unit. The distributor pick-up coil and trigger wheel provide the input signal for the control unit.

The trigger wheel, mounted on the distributor shaft, has one tooth for each engine cylinder. The wheel is mounted so that the teeth rotate past the pick-up coil one at a time.

The pick-up coil, a coil of fine gauge wire mounted on a permanent magnet, has a magnetic field that is intensified by the presence of ferrous metal. The pick-up coil reacts to the trigger wheel teeth as they pass. As a trigger wheel tooth approaches and passes the pole piece of the pick-up coil, it reduces the reluctance (compared to air) to the magnetic field and increases field strength. Field strength decreases as the tooth moves away from the pole piece. This build-up and reduction of field strength induces an alternating current into the pick-up coil, which triggers the control unit. The control unit opens and closes the coil primary circuit according to the position of the trigger wheel teeth.

There are no contacting surfaces between the trigger wheel and pick-up coil. Because there is no wear, the dwell angle requires no adjustment. The dwell angle is determined electronically by the control unit and is non-adjustable. When the ignition coil circuit is switched open, an electronic timer in the control unit keeps the circuit open only long enough for the electromagnetic field to collapse and the induced voltage to discharge. It then automatically closes the coil primary circuit. The period of time the circuit is closed is referred to as *dwell*.

Spark Advance

Efficient engine operation requires each spark to occur at the correct instant. Varying engine speed or engine load requires the spark to occur either earlier or later than it does for constant speed and load operation.

Mechanical advance is controlled by engine speed. Flyweights connected to the distributor shaft are thrown outward by centrifugal force. Higher engine rpm throws the weights further out. Calibrated-rate springs are used to control this movement. The outward motion of the flyweights causes the rotor and trigger wheel to be advanced on the distributor shaft several degrees in the direction of normal rotation. This is referred to as *centrifugal spark advance*.

When the engine is operating with a light load, the carburetor throttle plates restrict airflow. This causes a relatively lean mixture to enter the combustion chambers. Ignition must occur earlier because the lean mixture requires a longer time to burn. The vacuum spark advance unit is used for this purpose. When carburetor ported or manifold vacuum is high, the vacuum advance unit moves the pick-up coil several degrees opposite to the direction the distributor is rotating. This causes the pick-up coil to react to the presence of trigger wheel teeth earlier. This is referred to as *vacuum spark advance*. With low vacuum operating conditions, such as wide open throttle acceleration, a spring in the vacuum unit pushes the pick-up coil back to a position of no advance.

Cap and Rotor

The central tower on the distributor cap receives the high voltage current from the ignition coil. The current flows through a carbon button in the cap into a spring-loaded contact on the rotor. The rotor tip aligns with a contact in the cap that corresponds to the cylinder to be ignited just as the coil output high voltage current reaches the rotor. In this way, each spark plug is fired in turn.

OPERATION

The control unit is activated when the ignition switch is in the Start or On position (fig. 1G-14). The primary circuit is closed and current flows through the coil primary winding. When the engine begins turning the distributor, the trigger wheel teeth rotate past the pick-up coil. As each tooth aligns with the pick-up coil, a high voltage is induced in the ignition coil secondary winding and current flows to the distributor cap and rotor. The rotor routes the high voltage current to the proper spark plug. The timing of the ignition is constantly changed by the vacuum and centrifugal advance mechanisms according to engine operation.

TROUBLESHOOTING

For troubleshooting purposes, ignition system problems are considered in three categories: complete failure, intermittent failure and spark knock.

Complete failure is always a no-spark situation. The engine will not start. If a complete failure occurs when the engine is operating, it will not restart.

Intermittent failure is temporary. The engine may not start on the first try, but will eventually start. If an intermittent failure occurs when the engine is operating, it may falter and possibly stop. If it stalls, it will restart and will continue to operate intermittently.

Spark knock is not actually an ignition system failure. The engine will start and will continue to operate. If not corrected, spark knock can cause extensive internal engine component damage.

Complete Failure Diagnosis

The first step to perform is a thorough visual inspection for obvious defects.

The next step in diagnosing a failure is to identify the circuit—primary or secondary—at fault.

The primary circuit consists of:

- Battery to ignition coil wiring
- Ignition coil primary winding
- All wires connected to the electronic ignition control unit and distributor pick-up coil
- Electronic ignition control unit
- Distributor

The secondary circuit consists of:

- Ignition coil secondary winding
- All high voltage wires connected to the distributor cap, coil and spark plugs
- Distributor cap
- Distributor rotor
- Spark plugs

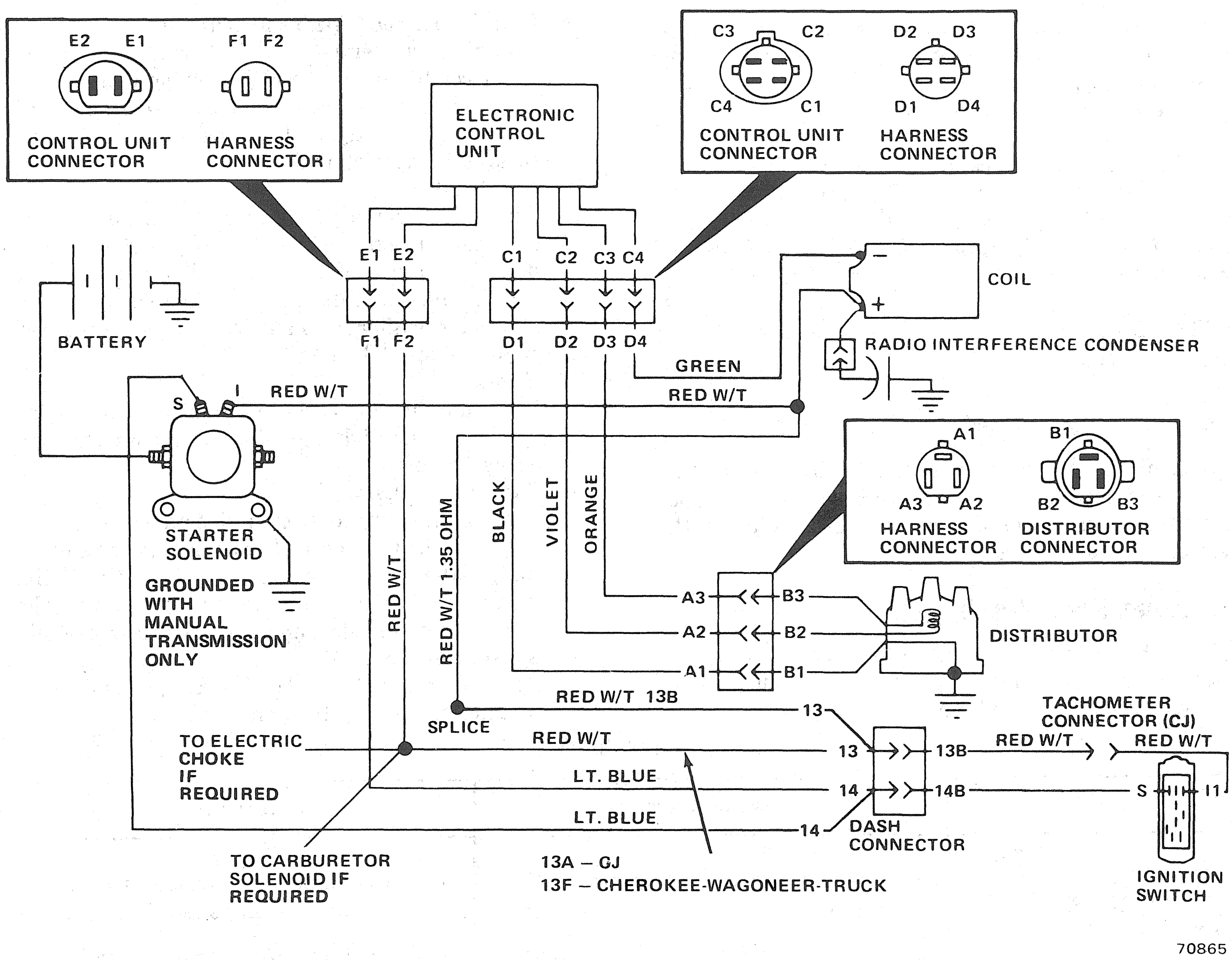


Fig. 1G-14 SSI System Schematic

Secondary Circuit Diagnosis

CAUTION: *When disconnecting a high voltage wire from a spark plug or the distributor cap, twist the rubber boot slightly to break it loose. Grasp the boot, not the wire, and pull off with steady, even force.*

(1) Disconnect ignition coil wire from center tower of distributor cap. Use insulated pliers to hold wire terminal approximately 1/2 inch from engine block or intake manifold.

WARNING: *Use extreme caution when engine is operating. Do not stand in direct line with fan. Do not put hands near pulleys, belts or fan. Do not wear loose clothing.*

(2) Crank engine and observe wire terminal for arc.

(a) If no arc occurs, proceed with step (5).

(b) If arc occurs, proceed with step (3).

CAUTION: *Do not remove wires from spark plugs for cylinders 1 or 5 of a six-cylinder engine or cylinders 3 or 4 of an eight-cylinder engine when performing this test, otherwise pick-up coil may be damaged.*

(3) Connect ignition coil wire to distributor cap. Remove wire from one spark plug.

(4) Use insulated pliers to hold wire 1/2 inch from engine cylinder head while cranking engine. Observe wire terminal for arc.

(a) If arc occurs, inspect for fuel system problems or incorrect ignition timing.

(b) If no arc occurs, inspect for defective rotor or distributor cap, or defective spark plug wires.

(5) If no arc occurs from ignition coil wire terminal, test coil secondary winding resistance. It should not exceed 10,000 ohms. Replace if required.

(6) Read following notes and proceed to SSI System Diagnosis and Repair Simplification (DARS) Chart 1.

NOTE: *The DARS charts are organized to permit testing of the primary sub-circuit separately and in the most logical sequence. When the problem is located, it is not necessary to perform additional tests.*

NOTE: *If a particular component or sub-circuit is suspected, locate the applicable DARS Chart and follow the procedures outlined. If no particular component or sub-circuit is suspected, begin with Chart 1 and proceed from chart to chart until the problem is located.*

NOTE: *Do not perform Chart 4 tests until after Chart 1 tests have been completed.*

Intermittent Failure Diagnosis

Intermittent failure may be caused by loose or corroded terminals, defective or missing components, poor ground connections or defective wiring. Refer to the Service Diagnosis chart.

Engine Spark Knock (Ping) Diagnosis

Spark knock can be attributed to several factors. The most common are ambient air conditions, such as air temperature, density and humidity.

- **High Underhood Air Temperature**
  Underhood air temperature is increased by the use of air conditioning (especially during long periods of idling), overloading (trailer pulling or operating in too high a gear), and the installation of accessories that restrict airflow.
- **Air Density**
  Air density increases as barometric pressure rises or as the air temperature decreases. A denser than normal mixture of air and fuel drawn into the cylinder has the same effect as increasing the engine compression ratio and this increases the possibility of spark knock.
- **Humidity**
  Low humidity increases the tendency for engine spark knock. High humidity decreases the tendency for spark knock.
- **Fuel Octane Rating**
  Fuels of an equivalent research octane rating may vary in their antiknock characteristics for a given engine. It may be necessary to retard the initial ignition timing (not more thàn 2 degrees from the specification) or select an alternate source of fuel.
- **Ignition Timing**
  Ignition timing should be checked to ensure it is adjusted to the specification.

SERVICE DIAGNOSIS

Condition	Possible Cause	Correction
ENGINE FAILS TO START (NO SPARK AT PLUGS)	(1) No voltage to ignition system	(1) Check battery, ignition switch and wiring. Repair as required
	(2) Electronic Control Unit ground lead inside distributor open, loose or corroded	(2) Clean, tighten or repair as required
	(3) Primary wiring connectors not fully engaged	(3) Clean and fully engage connectors
	(4) Coil open or shorted	(4) Test coil. Replace if faulty.
	(5) Electronic Control Unit defective	(5) Replace Electronic Control Unit
	(6) Cracked distributor cap	(6) Replace cap
	(7) Defective rotor	(7) Replace rotor
ENGINE BACKFIRES BUT FAILS TO START	(1) Incorrect ignition timing	(1) Check timing. Adjust as required
	(2) Moisture in distributor	(2) Dry cap and rotor
	(3) Distributor cap faulty	(3) Check cap for loose terminals, cracks and dirt. Clean or replace as required
	(4) Ignition wires connected in wrong firing order.	(4) Connect in correct order.

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SERVICE DIAGNOSIS (Continued)

Condition	Possible Cause	Correction
ENGINE RUNS ONLY WITH KEY IN START POSITION	(1) Open in resistance wire or excessive resistance	(1) Repair resistance wire
ENGINE CONTINUES TO RUN WITH KEY OFF	(1) Defective starter solenoid	(1) Replace solenoid
	(2) Defective ignition switch	(2) Replace ignition switch
ENGINE DOES NOT OPERATE SMOOTHLY AND/OR ENGINE MISFIRES AT HIGH SPEED	(1) Spark plugs fouled or faulty	(1) Clean and gap plugs. Replace as required
	(2) Ignition wires faulty.	(2) Check wires. Replace as required.
	(3) Spark advance system(s) faulty	(3) Check operation. Repair as required
	(4) I-terminal shorted to starter terminal in solenoid	(4) Replace solenoid
	(5) Trigger wheel pin missing	(5) Install pin
	(6) Ignition wires connected in wrong firing order.	(6) Connect wires correctly.
EXCESSIVE FUEL CONSUMPTION	(1) Incorrect ignition timing	(1) Check timing. Adjust as required
	(2) Spark advance system(s) faulty	(2) Check operation. Repair as required
ERRATIC TIMING ADVANCE	(1) Faulty vacuum or centrifugal advance assembly	(1) Check operation. Replace if required
TIMING NOT AFFECTED BY VACUUM	(1) Defective vacuum advance unit	(1) Replace vacuum advance unit
	(2) Pick-up coil pivot corroded.	(2) Clean pivot
INTERMITTENT OPERATION	(1) Loose or corroded terminals	(1) Tighten terminals, remove corrosion, apply electrical grease
	(2) Defective pick-up coil.	(2) Perform pick-up coil test.
	(3) Defective control unit	(3) Perform control unit tests
	(4) Loose ground connector in distributor	(4) Clean and tighten ground connection
	(5) Wires to distributor shorted together or to ground	(5) Check for frayed, pinched or burned wires
	(6) Trigger wheel pin missing	(6) Install new pin.

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SSI SYSTEM DIAGNOSIS AND REPAIR SIMPLIFICATION (DARS) CHART

Note: Refer to Chapter A — General Information for details on how to use this DARS chart.

IGNITION COIL PRIMARY CIRCUIT

FUNCTION: PROVIDES BATTERY FEED TO COIL AND COIL GROUND

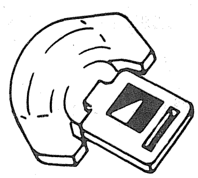
Chart 1

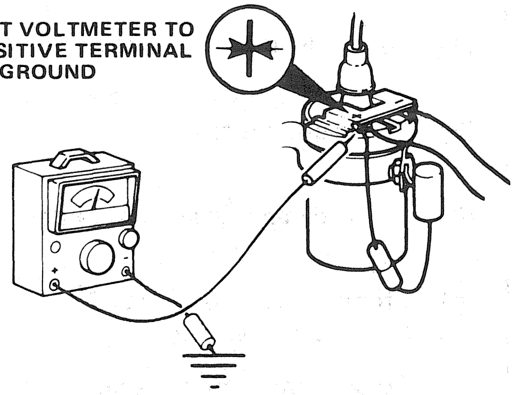
STEP | **SEQUENCE** | **RESULT**

1

REFER TO FIGURE 1G-14 FOR SCHEMATIC

● CONNECT VOLTMETER TO COIL POSITIVE TERMINAL AND TO GROUND





● TURN IGNITION ON

VOLTAGE ACCEPTABLE (6V ± .5V) — OK → 2

VOLTAGE NOT ACCEPTABLE (BATTERY VOLTAGE) — NOT OK → 4

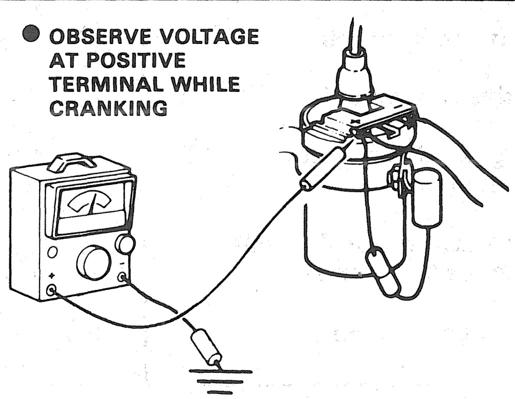
VOLTAGE NOT ACCEPTABLE (BELOW 6V) — NOT OK → DISCONNECT CAPACITOR WIRE TERMINAL →

- VOLTAGE ACCEPTABLE (6V ± .5V) — OK → REPLACE CAPACITOR → STOP
- VOLTAGE NOT ACCEPTABLE — NOT OK → 6

2

● TURN IGNITION SWITCH TO START

● OBSERVE VOLTAGE AT POSITIVE TERMINAL WHILE CRANKING



VOLTAGE ACCEPTABLE (BATTERY VOLTAGE) — OK → STOP

VOLTAGE NOT ACCEPTABLE (LESS THAN BATTERY VOLTAGE) — NOT OK → 3

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Chart 1

STEP | **SEQUENCE** | **RESULT**

3

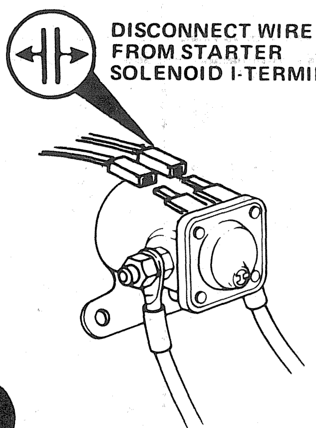
CHECK FOR SHORT OR OPEN IN WIRE ATTACHED TO STARTER SOLENOID 1-TERMINAL

CHECK SOLENOID AS OUTLINED IN CHAPTER 1F

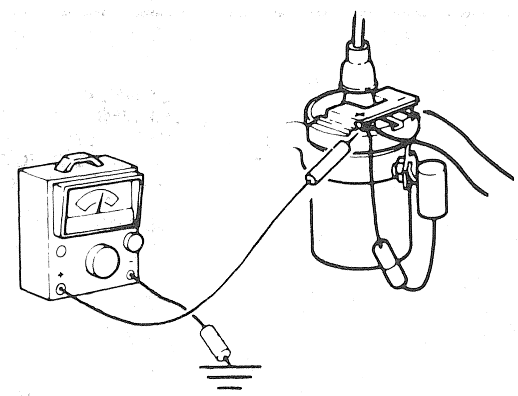
REPAIR AS REQUIRED → STOP

4

DISCONNECT WIRE FROM STARTER SOLENOID I-TERMINAL



- IGNITION REMAINS ON
- OBSERVE VOLTAGE AT COIL POSITIVE TERMINAL



VOLTAGE DROPS TO 6V ± .5V — OK → REPLACE STARTER SOLENOID → STOP

VOLTAGE REMAINS AT BATTERY VOLTAGE — NOT OK → CONNECT JUMPER BETWEEN COIL NEGATIVE TERMINAL AND GROUND

- VOLTAGE DROPS TO 6V ± .5V — OK → 5
- VOLTAGE DOES NOT DROP — NOT OK → REPAIR DEFECTIVE RESISTANCE WIRE → 2

5

CHECK:

- CONTINUITY BETWEEN COIL NEGATIVE TERMINAL AND CONNECT TERMINAL D4
- DI TO GROUND

CONTINUITY OK → REPLACE CONTROL UNIT → STOP

CONTINUITY NOT OK → LOCATE AND REPAIR OPEN → 2

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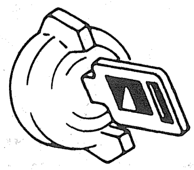
Chart 1

STEP	SEQUENCE	RESULT

6

- TURN IGNITION OFF



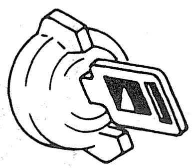
CONNECT OHMMETER BETWEEN COIL POSITIVE TERMINAL AND DASH CONNECTOR AV

RESISTANCE TOO HIGH (1.40 OHMS OR MORE) → REPAIR RESISTANCE WIRE → STOP

RESISTANCE ACCEPTABLE (1.35 ± .05 OHMS)

7

CONNECT OHMMETER BETWEEN DASH CONNECTOR AV AND IGNITION SWITCH TERMINAL I1



- IGNITION REMAINS OFF

OK: RESISTANCE ACCEPTABLE (LESS THAN 0.1 OHM) → REPLACE IGNITION SWITCH OR REPAIR SWITCH WIRE FROM BATTERY → STOP

RESISTANCE TOO HIGH (MORE THAN 0.1 OHM) → check:
- POOR TERMINAL CONNECTIONS AT DASH CONNECTOR OR IGNITION SWITCH
- DEFECTIVE WIRING

→ REPAIR DEFECT → STOP

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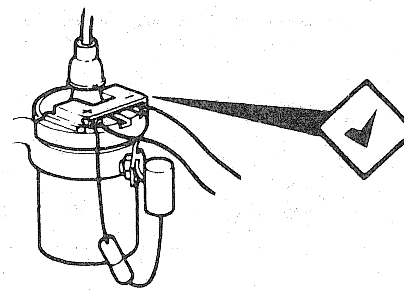
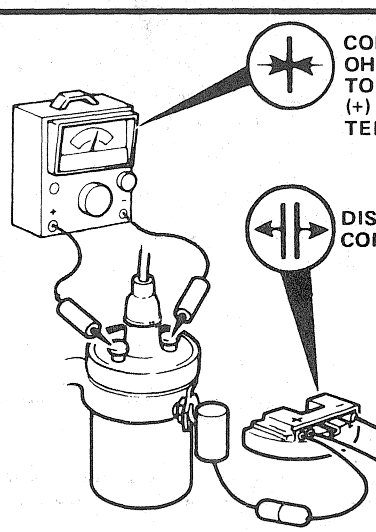
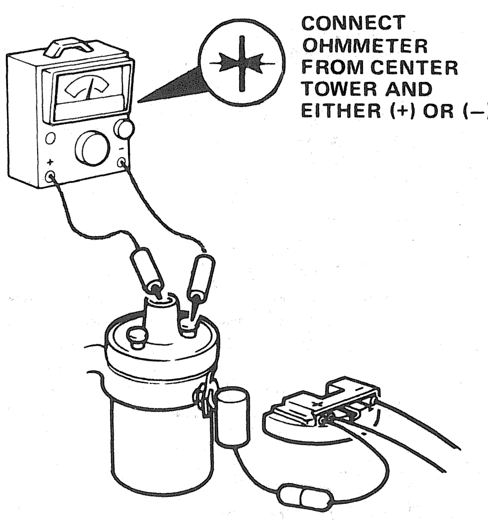
COIL TEST

Chart 2

STEP	SEQUENCE	RESULT
1	INSPECT COIL FOR OIL LEAKS, OTHER EXTERIOR DAMAGE, AND CARBON TRACKS OK →	2
	NOT OK → REPLACE COIL →	STOP
2	CONNECT OHMMETER TO COIL (+) AND (–) TERMINALS DISCONNECT COIL CONNECTOR OK → RESISTANCE ACCEPTABLE (1.13 TO 1.23 OHMS AT 75°F OR 24°C) (1.5 OHMS AT 200°F OR 93°C)	3
	NOT OK → RESISTANCE NOT WITHIN LIMITS → REPLACE COIL →	STOP
3	CONNECT OHMMETER FROM CENTER TOWER AND EITHER (+) OR (–) OK → RESISTANCE ACCEPTABLE (7700 - 9300 OHMS @ 75°F OR 24°C) (12,000 OHMS @ 200°F OR 93°C)	STOP
	NOT OK → RESISTANCE NOT WITHIN LIMITS → REPLACE COIL →	STOP







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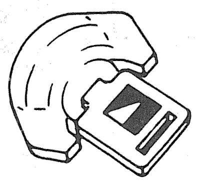
SENSOR CHECK AND CONTROL UNIT CHECK

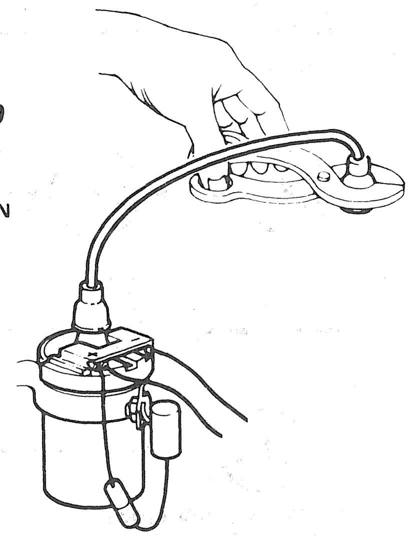
Chart 3

STEP	SEQUENCE	RESULT

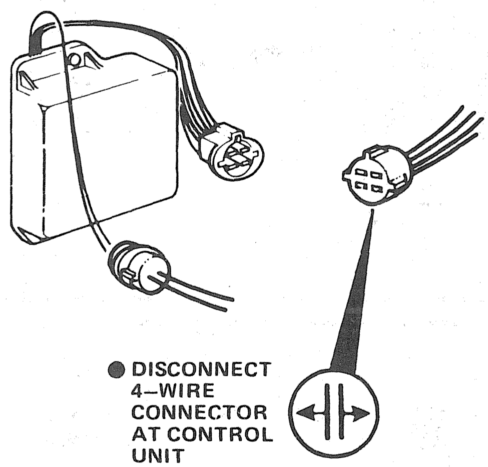
1



● TURN IGNITION ON



● DISCONNECT COIL WIRE FROM CENTER TOWER OF DISTRIBUTOR AND HOLD 1/2 - INCH FROM ENGINE WITH INSULATED PLIERS

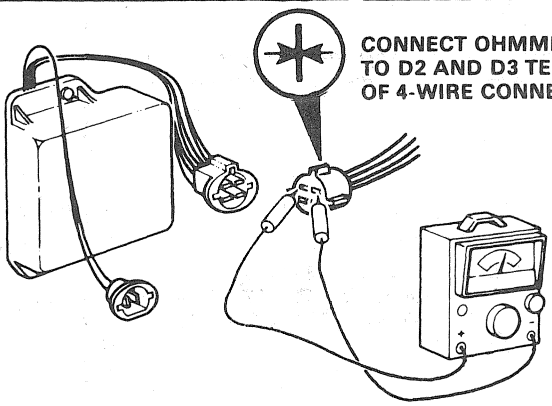


● DISCONNECT 4—WIRE CONNECTOR AT CONTROL UNIT

SPARK AT COIL WIRE (NORMAL) → 2

NO SPARK → 5

2



CONNECT OHMMETER TO D2 AND D3 TERMINAL OF 4-WIRE CONNECTOR

OK → 6

OHMMETER INDICATES 400-800 OHMS (NORMAL)

~~OK~~ → 3

OHMMETER DOES NOT INDICATE 400 - 800 OHMS

3

● DISCONNECT AND RECONNECT 3 - WIRE CONNECTOR AT DISTRIBUTOR

OK OHMMETER NOW INDICATES 400 - 800 OHMS → 6

~~OK~~ OHMMETER REMAINS OUTSIDE 400 - 800 OHMS → DISCONNECT 3 - WIRE CONNECTOR AT DISTRIBUTOR → 4

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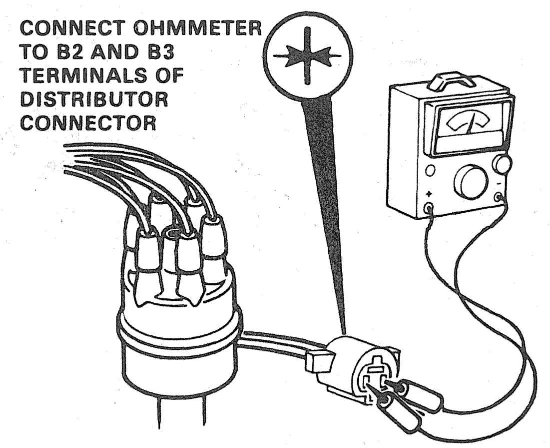
Chart 3

STEP | **SEQUENCE** | **RESULT**

4

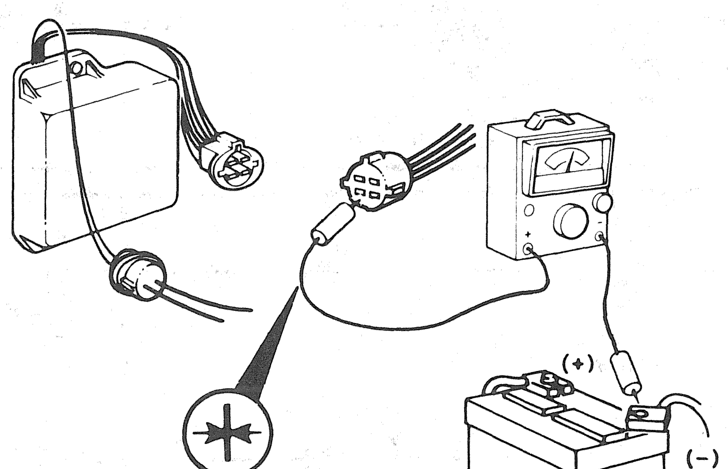
CONNECT OHMMETER TO B2 AND B3 TERMINALS OF DISTRIBUTOR CONNECTOR



OK — OHMMETER INDICATES, 400 - 800 OHMS → REPAIR OR REPLACE HARNESS BETWEEN 3 - WIRE AND 4 - WIRE CONNECTOR → STOP

NOT OK — OHMMETER DOES NOT INDICATE 400 - 800 OHMS → REPLACE PICK-UP COIL → STOP

5



CONNECT OHMMETER BETWEEN TERMINAL D1 AND BATTERY NEGATIVE TERMINAL

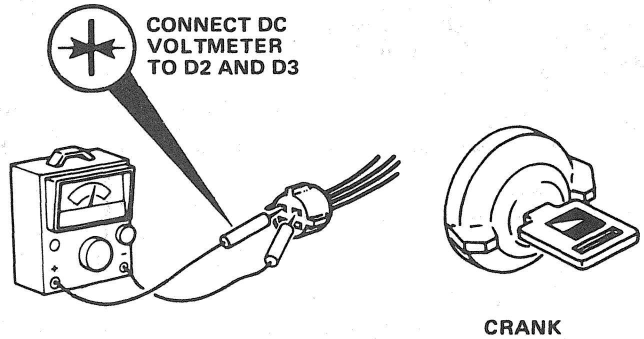
OK — OHMMETER INDICATES ZERO (NOT ABOVE 0.002 OHM) → 2

NOT OK — OHMMETER INDICATES ABOVE 0.002 OHM → LOCATE AND REPAIR SOURCE OF BAD GROUND → STOP

- GROUND CABLE RESISTANCE
- DISTRIBUTOR–TO–BLOCK RESISTANCE
- GROUND SCREW IN DISTRIBUTOR TO D1 TERMINAL

6

CONNECT DC VOLTMETER TO D2 AND D3



CRANK ENGINE

OK — VOLTMETER FLUCTUATES, INDICATING PROPER PICK-UP COIL AND TRIGGER WHEEL OPERATION → STOP

NOT OK — VOLTMETER DOES NOT FLUCTUATE → LOCATE AND REPAIR FAULT → STOP

- DEFECTIVE TRIGGER WHEEL
- DISTRIBUTOR NOT TURNING
- MISSING TRIGGER WHEEL PIN

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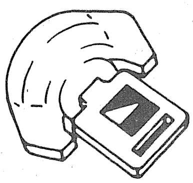
IGNITION FEED TO ELECTRONIC CONTROL UNIT

NOTE: DO NOT PERFORM CHART 4 WITHOUT PERFORMING CHART 1

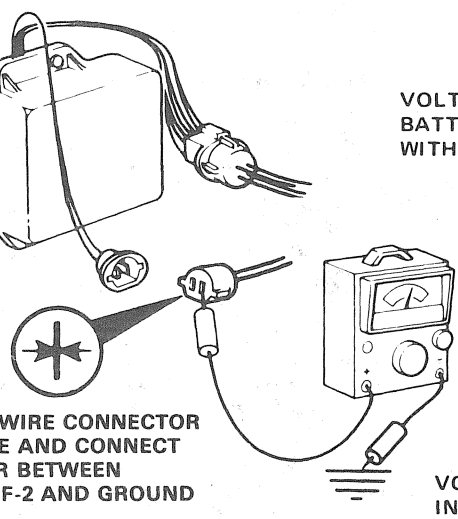
Chart 4

STEP | **SEQUENCE** | **RESULT**

1



● TURN IGNITION ON



UNPLUG 2-WIRE CONNECTOR AT MODULE AND CONNECT VOLTMETER BETWEEN TERMINAL F-2 AND GROUND

OK → VOLTMETER INDICATES BATTERY VOLTAGE WITHIN 0.2V. → REPLACE CONTROL UNIT → 3

NOT OK → VOLTMETER DOES NOT INDICATE BATTERY VOLTAGE WITHIN 0.2V → 2

2

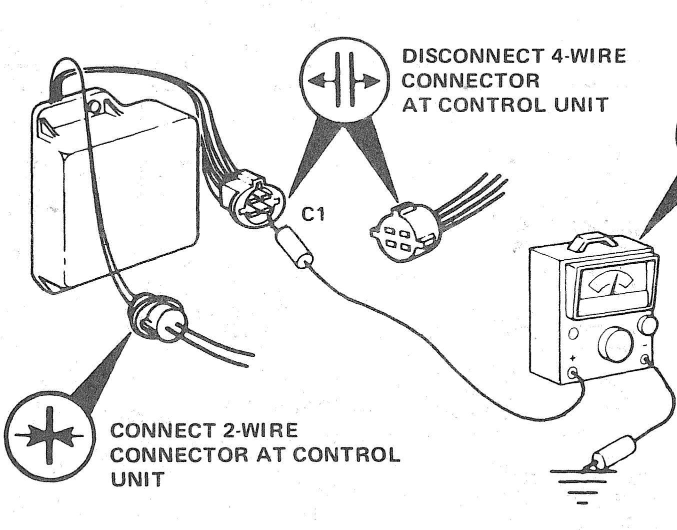
LOCATE AND REPAIR CAUSE OF VOLTAGE REDUCTION

- CORRODED DASH CONNECTOR
- IGNITION SWITCH

OK → SPARK AVAILABLE AT COIL WIRE → STOP

NOT OK → SPARK NOT AVAILABLE AT COIL WIRE → REPLACE CONTROL UNIT → STOP

3



DISCONNECT 4-WIRE CONNECTOR AT CONTROL UNIT

CONNECT 2-WIRE CONNECTOR AT CONTROL UNIT

CONNECT AMMETER BETWEEN TERMINAL C1 AND GROUND

OK → AMMETER INDICATES 1 AMP ± 0.1 → STOP

NOT OK → AMMETER INDICATES HIGHER OR LOWER → REPLACE MODULE → STOP

80699G

Ignition Coil Tests

The ignition coil can be tested on any conventional coil tester or with an ohmmeter. A coil tester is preferable because it can be used to detect faults that are impossible to detect with an ohmmeter.

Primary Winding Resistance Test

(1) Remove connector from negative (-) and positive (+) terminals of coil.

(2) Set ohmmeter for low scale and adjust pointer to zero.

(3) Connect ohmmeter to coil negative (-) and positive (+) terminals. Resistance should be 1.13 to 1.23 ohms at 75°F (24°C). If coil temperature is above 200°F (93°C), 1.50 ohms is acceptable.

Secondary Winding Resistance Test

(1) Remove ignition wire from center terminal of ignition coil.

NOTE: *Ignition switch must be off.*

(2) Set ohmmeter for x1000 scale and adjust pointer to zero.

(3) Connect ohmmeter to brass contact in center terminal and to either primary winding terminal. Resistance should be 7700 to 9300 ohms at 75°F (24°C). A maximum of 12,000 ohms is acceptable if coil temperature is 200°F (93°C) or more.

Current Flow Test

(1) Remove connector from ignition coil.

(2) Depress plastic barb and withdraw positive (+) terminal wire from connector. Barb is visible from coil side of connector.

(3) Repeat for negative (-) terminal wire.

(4) Connect ammeter between positive (+) terminal and disconnected positive (+) terminal wire.

(5) Connect jumper wire from coil negative (-) terminal to known good ground.

(6) Turn ignition switch to ON position.

(7) Current flow should be approximately 7 amps and should not exceed 7.6 amps.

(8) If current flow is more than 7.6 amps, replace ignition coil.

(9) Leave ammeter connected to coil positive (+) terminal. Remove jumper wire from negative (-) terminal. Connect coil green wire to negative (-) terminal. Current flow should be approximately 4 amps.
If current flow is less than 3.5 amps, inspect for poor connections in 4-wire (control unit) and 3-wire (distributor) connectors or poor ground at ground screw inside distributor. If current flow is greater than 5 amps, the control unit is defective.

WARNING: *Use extreme caution when engine is operating. Do not stand in direct line with fan. Do not put hands near pulleys, belts or fan. Do not wear loose clothing.*

(10) Start engine. Normal current flow with engine operating is 2.0 to 2.4 amps. If current flow is not within specifications, control unit is defective.

Ignition Coil Output Tests

(1) Connect oscilloscope to ignition coil. Refer to test equipment manufacturer's instructions.

WARNING: *Use extreme caution when engine is operating. Do not stand in direct line with fan. Do not put hands near pulleys, belts or fan. Do not wear loose clothing.*

(2) Start engine and observe secondary spark voltage.

CAUTION: *Do not remove wires from spark plugs for cylinders 1 or 5 of a six-cylinder engine or cylinders 3 or 4 of an eight-cylinder engine when performing the next test because the pick-up coil may be damaged.*

CAUTION: *Do not operate engine with spark plug disconnected for more than 30 seconds or catalytic converter may be damaged.*

(3) Remove one spark plug wire from distributor cap. Observe voltage applied to disconnected spark plug wire on oscilloscope. This voltage, referred to as open circuit output voltage, should be 24,000 volts (24 kV) minimum with engine speed of 1000 rpm.

DISTRIBUTOR REPLACEMENT

Removal

(1) Unfasten distributor cap retaining screws. Remove distributor cap with ignition coil and spark plug wires connected and position aside.

(2) Disconnect distributor vacuum advance hose.

(3) Disconnect distributor primary wiring connector.

(4) Scribe mark on distributor housing in line with tip of rotor. Scribe mark on distributor housing near clamp and continue scribe mark on engine block in line with distributor mark. Note position of rotor and distributor housing in relation to surrounding engine parts as reference points for installing distributor.

(5) Remove distributor holddown bolt and clamp.

(6) Withdraw distributor carefully from engine block.

Installation

(1) Clean distributor mounting area of engine block.

(2) Install replacement distributor mounting gasket in counterbore of engine block.

(3) Position distributor shaft in engine block. If engine was not rotated while distributor was removed, perform the following:

(a) Align rotor tip with mark scribed on distributor housing during removal. Turn rotor approximately 1/8-turn counterclockwise past scribe mark.

CAUTION: *Ensure that the distributor shaft fully engages the oil pump gear shaft. It may be necessary to slightly rotate (bump) the engine while applying downward hand force on the distributor body to fully engage the distributor shaft with the oil pump drive gear shaft.*

(b) Slide distributor down into engine block. Align scribe mark on distributor housing with matching scribe mark on engine block.

NOTE: *It may be necessary to move the rotor and shaft slightly to start gear into mesh with camshaft gear and to engage oil pump drive tang, but rotor should align with scribe mark when distributor is down in place.*

(c) Install distributor holddown clamp, bolt and lockwasher, but do not tighten bolt.

(4) If engine was rotated while distributor was removed, it will be necessary to establish timing as follows:

(a) Remove No. 1 spark plug. Hold finger over spark plug hole and rotate engine until compression pressure is felt. Slowly continue to rotate engine until timing index on vibration damper pulley aligns with top dead center (TDC) mark on timing degree scale. Always rotate engine in direction of normal rotation. Do not turn engine backward to align timing marks.

(b) Turn distributor shaft until rotor tip points in direction of No. 1 terminal in distributor cap. Turn rotor 1/8-turn counterclockwise past position of No. 1 terminal.

(c) Slide distributor shaft down into engine and position distributor vacuum advance mechanism in approximately same location (in relation to surrounding engine parts) as when removed. Align scribe mark on distributor housing with corresponding scribe mark on engine block.

NOTE: *It may be necessary to rotate the oil pump shaft with a long, flat-blade screwdriver to engage oil pump drive tang, but rotor should align with the position of No. 1 terminal when distributor shaft is down in place.*

(d) Install distributor holddown clamp, bolt and lockwasher, but do not tighten bolt.

CAUTION: *If distributor cap is incorrectly positioned on distributor housing, cap or rotor may be damaged when engine is rotated.*

(5) Install distributor cap (with ignition wires) on distributor housing. Ensure pick-up coil wire rubber grommet in distributor housing aligns with depression in distributor cap and that cap fits on rim of distributor housing.

NOTE: *Two different diameter screws are used to retain distributor cap.*

(6) Apply Jeep Silicone Dielectric Compound, or equivalent, to connector terminal blades and cavities. Connect distributor primary wiring connector. Press firmly to overcome hydraulic pressure caused by silicone compound.

NOTE: *If connector locking tabs weaken or break off, bind connectors together with harness tie strap or tape to assure good electrical connection.*

CAUTION: *Do not puncture spark plug wires or boots to make connection. Use proper adapters.*

(7) Connect timing light to No. 1 spark plug.

NOTE: *The timing case cover has a socket adjacent to the timing degree scale for use with a magnetic timing probe. Ignition timing may be checked by inserting the probe through the hole until it rests on the vibration damper. The probe is calibrated to compensate for probe socket location, which is 9.5° ATDC. Eccentricity of the damper will properly space the magnetic probe. The timing degrees are indicated on a meter.*

WARNING: *Use extreme caution when engine is operating. Do not stand in direct line with fan. Do not put hands near pulleys, belts or fan. Do not wear loose clothing.*

(8) Operate engine at 500 rpm and observe vibration damper index and timing degree scale with timing light. Rotate distributor housing as needed to align timing index on vibration damper pulley with correct mark on timing degree scale. Refer to Chapter 1A—General Service and Diagnosis for ignition timing specifications. When ignition timing is correct, tighten distributor holddown bolt and recheck timing to ensure it did not change.

(9) Disconnect timing light and connect vacuum hose to distributor vacuum advance mechanism.

DISTRIBUTOR COMPONENT REPLACEMENT

When replacing the pick-up coil, trigger wheel or vacuum advance mechanism, it is not necessary to remove the distributor from the engine. It is necessary to check ignition timing if the pick-up coil or vacuum advance mechanism is replaced. Refer to figure 1G-15 for parts identification.

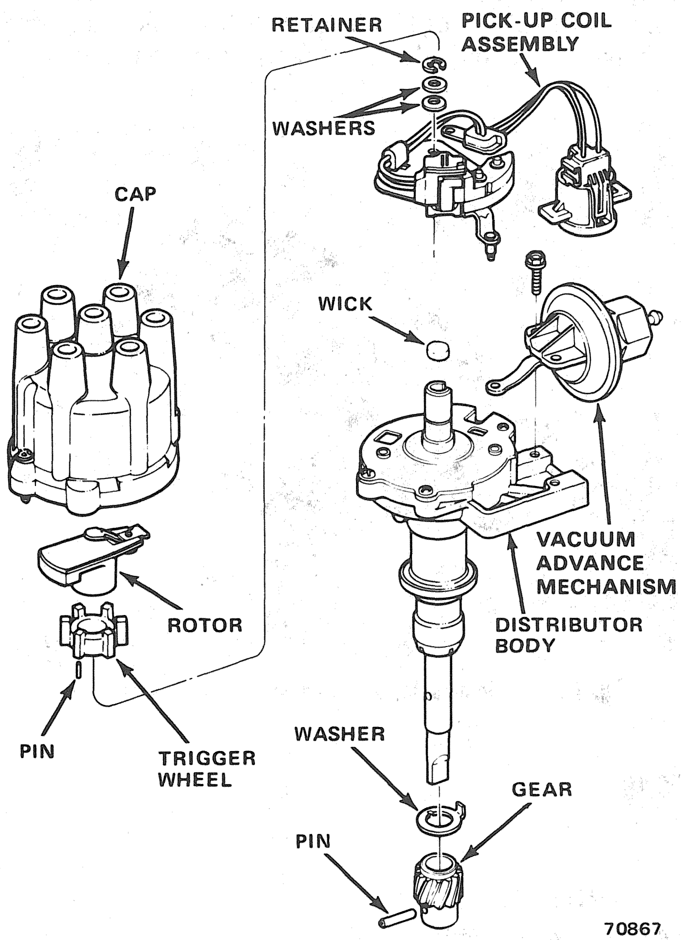


Fig. 1G-15 SSI Distributor Components—Six-Cylinder Engine

Trigger Wheel and/or Pick-up Coil

Removal

(1) Place distributor in suitable holding device, if removed from engine.

(2) Remove cap.

(3) Remove rotor.

(4) Remove trigger wheel with trigger wheel puller J-28509, or equivalent. Use flat washer to prevent puller from contacting inner shaft. Alternately, two screwdrivers can be used to remove trigger wheel from shaft. Remove pin.

(5) Six-cylinder engine—remove pick-up coil retainer and washers from pivot pin on base plate.

(6) Eight-cylinder engine—remove pick-up coil snap ring from central shaft. Remove retainer from vacuum advance mechanism-to-pick-up coil drive pin and move vacuum advance mechanism lever aside.

(7) Remove ground screw from harness tab.

(8) Lift pick-up coil assembly from distributor housing.

(9) If vacuum advance mechanism is to be replaced, remove screws and lift unit out of distributor housing. Do not remove vacuum advance mechanism unless replacement is required.

Installation

(1) If vacuum advance mechanism was removed, install it on distributor housing with attaching screws.

NOTE: *If replacement vacuum advance mechanism is installed, refer to Vacuum Advance Mechanism for calibration procedure.*

(2) Position pick-up coil assembly into distributor housing.

(3) Ensure pin on pick-up coil fits into hole in vacuum advance mechanism link (six-cylinder engines). Attach vacuum advance mechanism lever and retainer to pick-up coil pin (eight-cylinder engines).

(4) Install washers and retainer onto pivot pin to secure pick-up coil assembly to base plate (six-cylinder engines). Install snap ring (eight-cylinder engines).

(5) Position wiring harness in slot in distributor housing. Install ground screw through tab and tighten.

(6) Install trigger wheel on shaft with hand pressure. Long portion of teeth must be upward. When trigger wheel and slot in shaft are properly aligned, use suitable drift and small hammer to tap pin into locating groove in trigger wheel and shaft. If distributor is not installed in engine, support shaft while installing trigger wheel pin.

(7) Install rotor. Install distributor cap.

Vacuum Advance Mechanism

Removal

(1) Remove vacuum hose from vacuum advance mechanism.

(2) Six-cylinder engine—remove attaching screws and remove vacuum advance mechanism from distributor housing. It is necessary to tilt mechanism to disengage link from pick-up coil pin protruding through distributor housing. It may be necessary to loosen base plate screws for necessary clearance.

(3) Eight-cylinder engine—remove distributor cap. Remove retainer from pick-up coil pin. Remove attaching screws and lift vacuum advance mechanism from distributor housing.

Installation

(1) If replacement vacuum advance mechanism is to be installed, calibrate as follows:

(a) Insert Allen wrench into vacuum hose tube of original vacuum advance mechanism. Count number of **clockwise** turns necessary to bottom adjusting screw.

(b) Turn adjusting screw of replacement vacuum advance mechanism clockwise to bottom. Turn counterclockwise same number of turns counted in step (a).

(2) Six-cylinder engine—install vacuum advance mechanism on distributor housing. Ensure that vacuum advance link is engaged with pick-up coil pin. Install retaining screws. Tighten base plate screws, if loosened.

(3) Eight-cylinder engine—install vacuum advance mechanism on distributor housing. Install retaining screws. Position vacuum advance lever onto pick-up coil pin and install retainer. Install distributor cap.

(4) Check timing and adjust if required.

(5) Connect vacuum hose to vacuum advance mechanism.

Rotor

Inspect the rotor during precision tune-ups as outlined in Chapter 1A—General Service and Diagnosis.

A unique feature of the SSI system is the silicone dielectric compound applied to the rotor blade during manufacture. Radio interference is greatly reduced by the presence of a small quantity of this dielectric on the rotor blade. After a few thousand miles, the dielectric becomes charred by the high voltage current carried by the rotor (fig. 1G-16). This is normal. Do not scrape the residue from the rotor blade.

When installing a replacement rotor, always apply a thin coat (0.03 to 0.12 inch) of AMC Silicone Dielectric Compound, or equivalent, to the tip of the rotor blade.

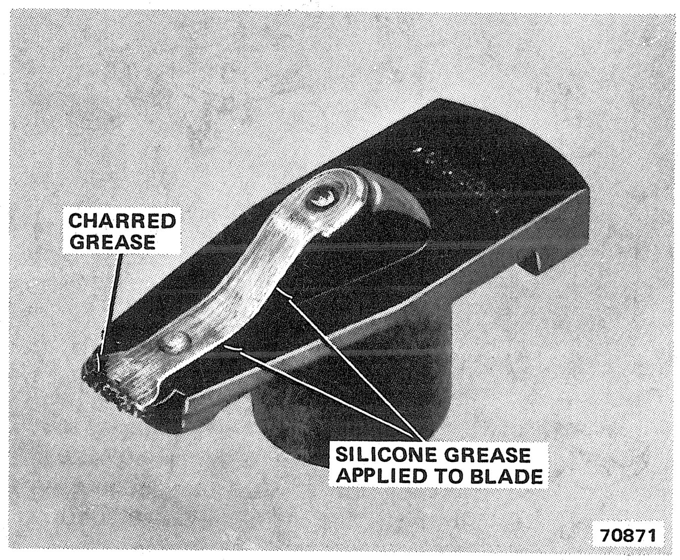


Fig. 1G-16 Rotor Silicone Dielectric Compound Application

SPECIFICATIONS

SSI Distributor and Coil Specifications

Distributor Pick-Up Coil Resistance	400 to 800 ohms @ 75°F (24°C)
Coil	
Primary Resistance	1.13 to 1.23 ohms @ 75°F (24°C)
	1.5 ohms @ 200°F (93°C)
Secondary Resistance	7700 to 9300 ohms @ 75°F (24°C)
	12,000 ohms @ 200°F (93°C)
Minimum Open Circuit Output at 1000 rpm	24 kv
Spark Plugs	
Required Voltage at 1000 rpm	5 to 16 kv
Maximum Variation Between Cylinders	3 to 5 kv

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Torque Specifications

Service Set-To Torques should be used when assembling components. Service In-Use Recheck Torques should be used for checking a pre-torqued item.

	USA (ft-lbs) Service Set-To Torque	USA (ft-lbs) Service In-Use Recheck Torque	Metric (N·m) Service Set-To Torque	Metric (N·m) Service In-Use Recheck Torque
Distributor Clamp Screw	13	10-18	18	13-24
Spark Plugs	28	22-33	38	30-45

All Torque values given in foot-pounds and newton-meters with dry fits unless otherwise specified.

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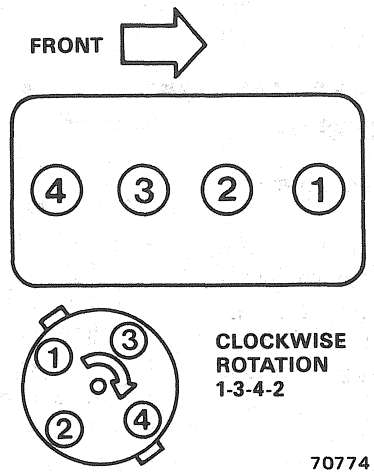
Distributor Wiring Sequence and Firing Order

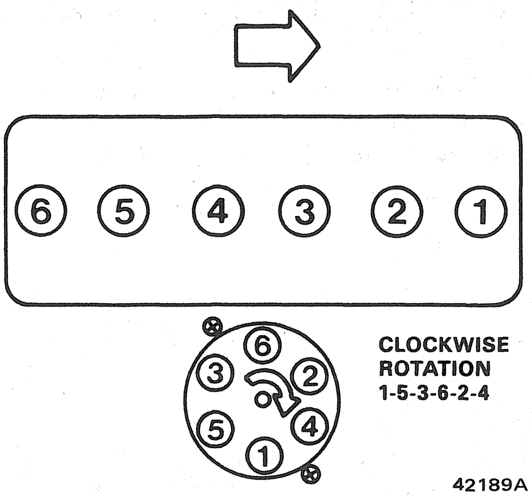
FRONT



CLOCKWISE
ROTATION
1-3-4-2

70774

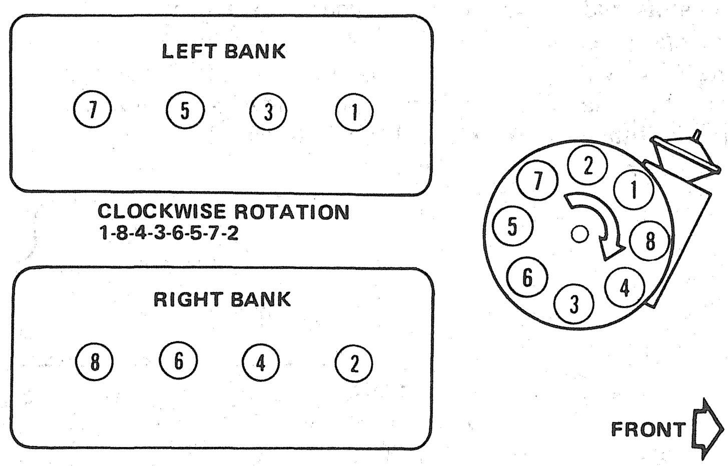
FOUR CYLINDER ENGINE



CLOCKWISE
ROTATION
1-5-3-6-2-4

42189A

SIX CYLINDER ENGINE

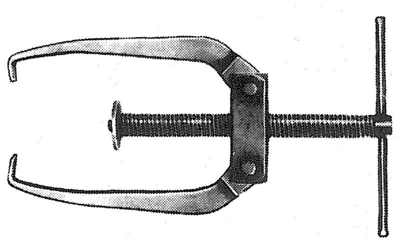


FRONT

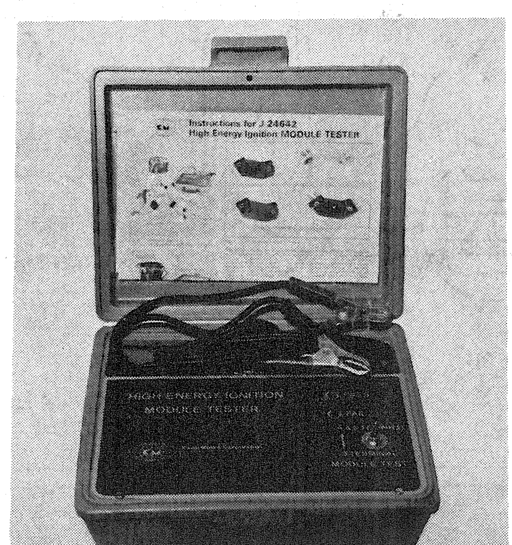
42189B

EIGHT CYLINDER ENGINE

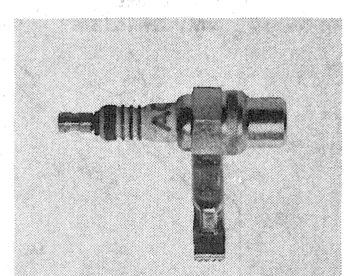
Tools



J-28509
TRIGGER WHEEL
PULLER



J-24642 HEI MODULE TESTER



J-26792 HEI
SPARK TESTER

SPARK CONTROL SYSTEMS

SPARK CONTROL SYSTEM—FOUR-CYLINDER ENGINE

California and 49-State four-cylinder CJ engines use only manifold vacuum for distributor spark advance. A delay valve maintains the vacuum advance during sudden throttle openings when the coolant temperature is below 120°F (49°C). The delay valve is bypassed by the spark CTO valve when the coolant temperature is above 120°F (49°C). Refer to figure 1G-17 for a diagram of the system.

Spark Coolant Temperature Override (CTO) Valve

The spark CTO valve is screwed into the thermostat housing to allow the thermal sensor to be in contact with the engine coolant. Depending on coolant temperature, the CTO valve (fig. 1G-18) permits manifold vacuum with the delay function or manifold vacuum without the delay function to control the distributor vacuum advance.

Operation

When the engine coolant temperature is below 120°F (49°C), manifold vacuum at port 1 is applied to port D. A hose connects port D with the distributor spark advance mechanism. The delay valve is in the circuit when the valve is in this position.

When the engine coolant temperature reaches 120°F (49°C), manifold vacuum at port 2 is also applied to port D but the delay valve is bypassed. This may be considered the normal operating mode.

Functional Test

(1) Disconnect vacuum hose from distributor vacuum advance mechanism. Connect vacuum gauge to vacuum hose.

WARNING: *Use extreme caution when engine is operating. Do not stand in direct line with fan. Do not put hands near pulleys, belts or fan. Do not wear loose clothing.*

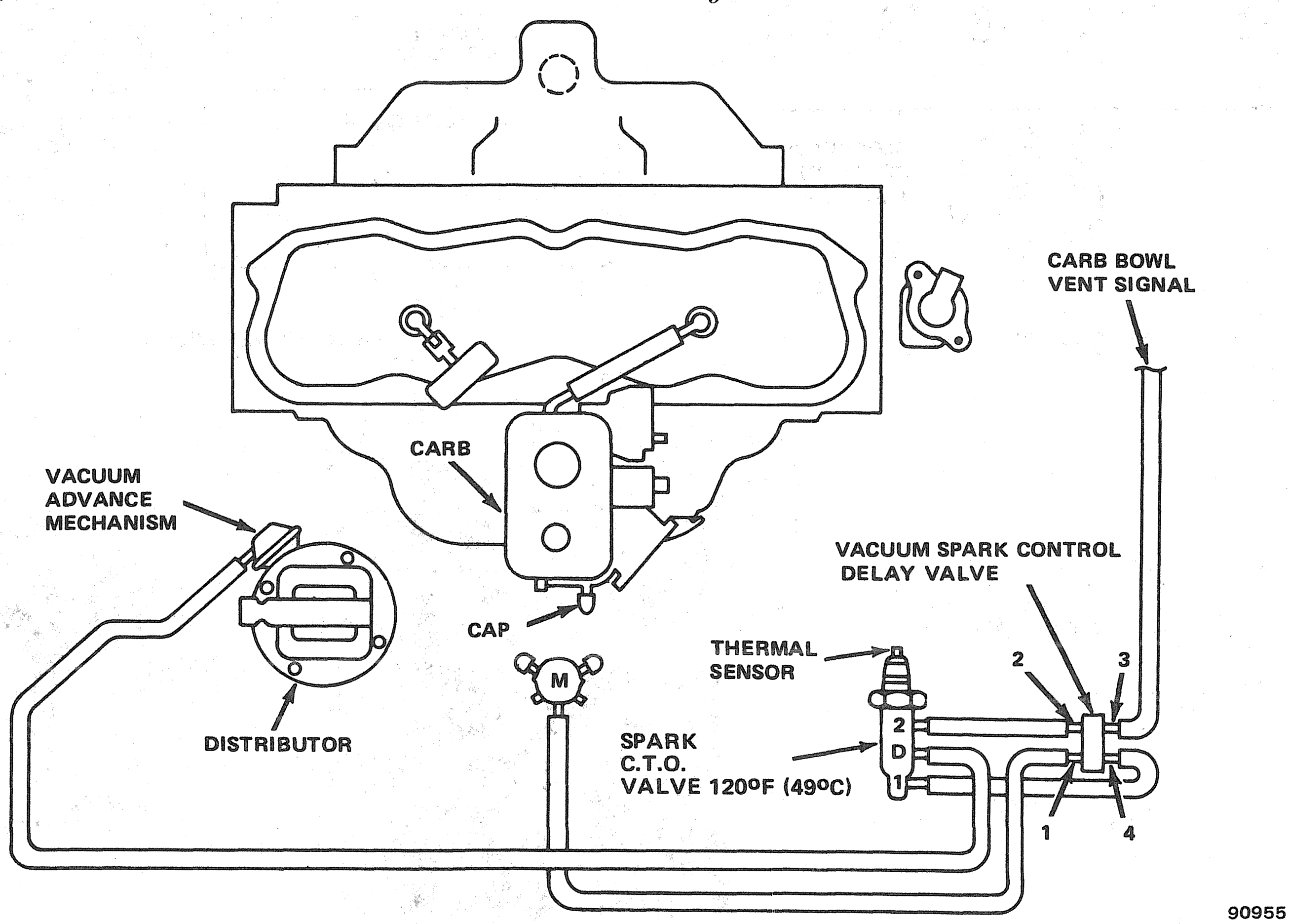


Fig. 1G-17 Spark Control System—Four-Cylinder Engines

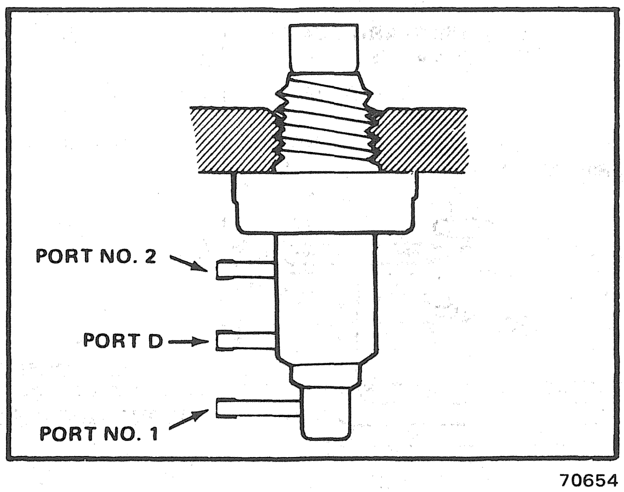


Fig. 1G-18 Spark CTO Valve

(2) Start engine.

(3) With engine coolant temperature below 120°F (49°C), manifold vacuum should be indicated on gauge.

(4) Disconnect vacuum hose from port 4 of delay valve and cap port (air tight).

(5) Manifold vacuum should not be indicated on gauge with engine coolant temperature below 120°F (49°C).

(6) Allow engine coolant temperature to reach 120°F (49°C). Manifold vacuum should be indicated on gauge.

NOTE: *The 120°F (49°C) CTO valve switching temperature is a nominal value. The actual switching temperature may vary slightly from unit to unit.*

(7) Stop engine.

(8) Remove cap from port 4 of delay valve and connect vacuum hose.

(9) Remove gauge and connect hose to distributor advance mechanism.

(10) If defective, replace valve.

Spark CTO Valve Replacement

WARNING: *If engine has been recently operated, use care to prevent scalding by hot coolant. System is pressurized.*

(1) Drain coolant from radiator until level is below CTO valve.

(2) Identify vacuum hoses and disconnect from CTO valve.

(3) Place drain pan under engine directly below CTO valve.

(4) With 7/8-inch open end wrench, remove CTO valve from thermostat housing.

(5) Install CTO valve.

(6) Connect vacuum hoses to valve.

(7) Install coolant.

WARNING: *Use extreme caution when engine is operating. Do not stand in direct line with fan. Do not put hands near pulleys, belts or fan. Do not wear loose clothing.*

(8) Start engine and inspect for coolant leaks.

(9) Test CTO valve as outlined in Functional Test.

Vacuum Spark Control Delay Valve

A vacuum spark control delay valve is added to the vacuum advance circuit to provide improved driveability when the engine is cold (fig. 1G-19). Ports 1 and 2, and ports 3 and 4 are connected internally.

When vacuum is greater at port 4 than at port 1 (e.g., sudden acceleration), air must flow through the orifice to equalize the pressure. This creates a momentary delay that prevents a sudden decrease in the spark advance. When the vacuum is greater at port 1 than at port 4, air flows freely through the unseated check valve and the pressure is instantly equalized.

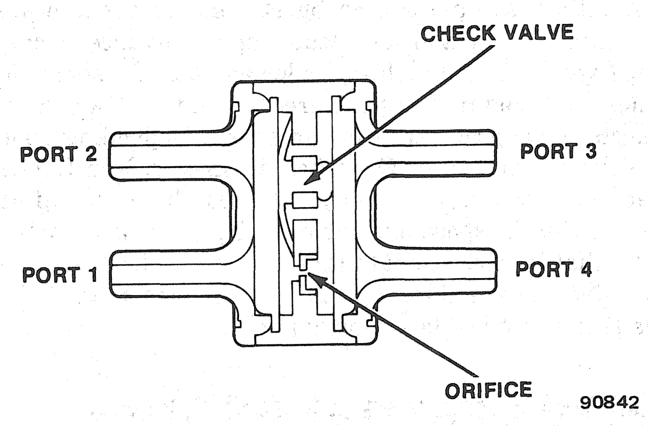


Fig. 1G-19 Vacuum Spark Control Delay Valve

Functional Test

(1) Connect tee fitting at port 1 and port 4.

(2) Connect vacuum gauge to each tee fitting.

WARNING: *Use extreme caution when engine is operating. Do not stand in direct line with fan. Do not put hands near pulleys, belts or fan. Do not wear loose clothing.*

(3) Start engine.

(4) Observe gauges. Vacuum should be equal.

(5) When throttle is suddenly depressed, vacuum at port 1 will instantly decrease but vacuum at port 4 should be maintained momentarily.

(6) Stop engine.

(7) If defective, replace delay valve.

(8) Remove gauges and tee fittings.

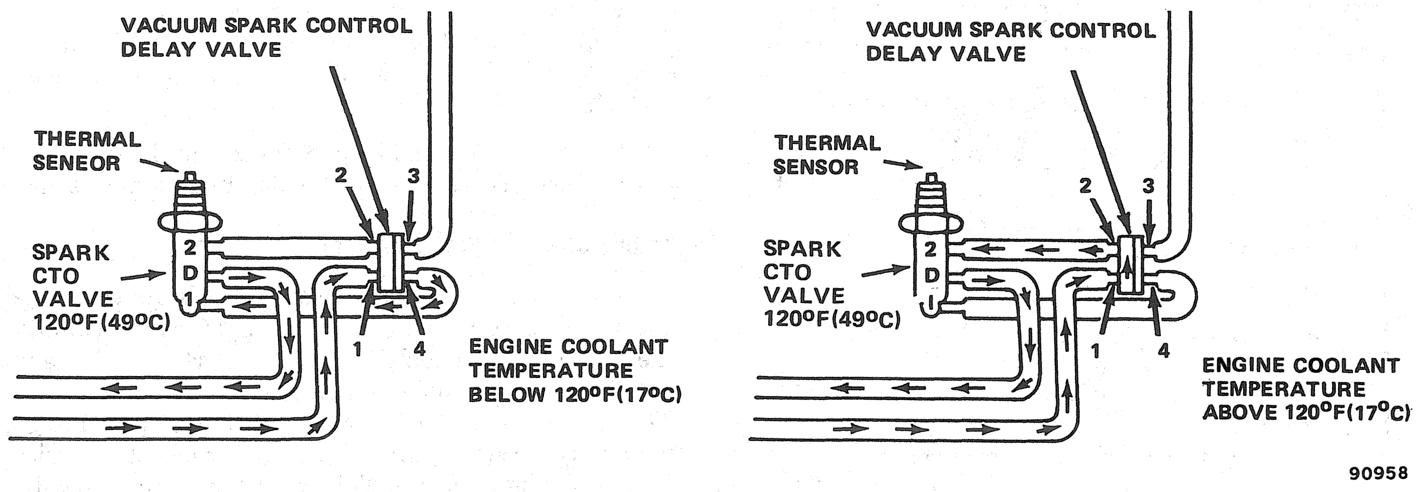


Fig. 1G-20 Spark Control System Operation

SPARK CONTROL SYSTEM—SIX- AND EIGHT-CYLINDER ENGINES

Manifold vacuum and carburetor ported vacuum are both used for the ignition vacuum spark advance mechanism with six- and eight-cylinder engines. On some engines, a Coolant Temperature Override (CTO) valve selects the appropriate vacuum source, depending upon coolant temperature. On other engines, a Non-Linear Vacuum Regulator (NLVR) valve combines manifold vacuum at idle speed and carburetor ported vacuum at a ratio that is proportional to the amount of throttle opening. Refer to the Emission Components charts in Chapter 1A for applicable engine application.

Spark Coolant Temperature Override (CTO) Valve—Standard Cooling System

General

On six- and eight-cylinder engines with a spark CTO valve, the distributor vacuum spark advance is controlled by carburetor ported vacuum after the engine coolant warms to a predetermined temperature. Warm-up driveability is improved by controlling the spark advance by manifold vacuum while the engine is cold. This is accomplished by the spark control system (fig. 1G-21). The CTO valve is screwed into the intake manifold coolant passage on six-cylinder engines, and into the thermostat housing or intake manifold coolant passage on eight-cylinder engines. A thermal sensor in the CTO valve is in contact with engine coolant (fig. 1G-22). Depending on coolant temperature, the CTO valve permits either manifold vacuum or carburetor ported vacuum to control distributor vacuum advance.

NOTE: *Some engine applications utilize a standard cooling system CTO valve in conjunction with a heavy duty cooling system CTO valve. Refer to Vacuum Diagrams for actual applications.*

Operation

When coolant temperature is below 149°F (65°C), manifold vacuum is exposed at port 1 and is applied to port D. A hose connects port D with the distributor spark vacuum advance mechanism diaphragm. In this operating mode, full vacuum advance is obtained.

When engine coolant reaches 149°F (65°C), valve is moved upward, blocking manifold vacuum at port 1. Carburetor ported vacuum is exposed at port 2 and is applied to port D. The distributor spark vacuum advance mechanism diaphragm is now controlled by ported vacuum. This may be regarded as the normal operating mode.

Functional Test

Connect a vacuum gauge to the center port (D) of the CTO valve. Below 149°F (65°C) manifold vacuum should be indicated on gauge. Above 149°F (65°C) carburetor ported vacuum should be indicated on gauge. Defective valves must be replaced.

NOTE: *Ported vacuum is not available with the throttle closed. Ported vacuum is only available when the throttle is opened to achieve an engine speed of approximately 1000 rpm.*

Spark Coolant Temperature Override (CTO) Valve—Heavy-Duty Cooling System

General

This is a single function valve that is utilized in conjunction with a heavy-duty cooling system to prevent overheating during high ambient temperatures. It is connected to the engine coolant passage in the same place as the CTO valve used with standard cooling systems.

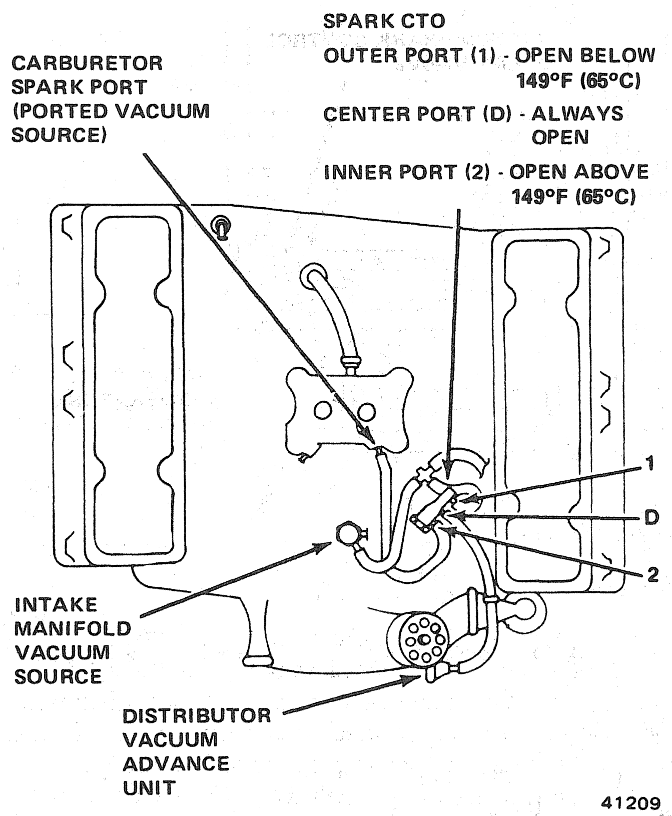


Fig. 1G-21 Spark Control System—Typical—Six- and Eight-Cylinder Engines With Standard Cooling System

NOTE: *Some engine applications utilize a heavy-duty cooling system CTO valve in conjunction with a standard cooling system CTO valve. Refer to Vacuum Diagrams for actual applications.*

Operation

When the coolant temperature is below the switching temperature (220°F [104°C]), ported vacuum is exposed at port 1 and applied to port D to allow ported vacuum to control the distributor vacuum advance. When the coolant temperature reaches 220°F (104°C), port 1 closes and port 2 is connected to port D to allow manifold vacuum to control the distributor vacuum advance. With manifold vacuum applied to the vacuum advance mechanism, engine idle speed is increased thereby improving engine cooling efficiencies and reducing idle speed boiling tendencies.

Functional Test

(1) Connect vacuum gauge to port D (Dist.) of the heavy-duty cooling system CTO valve. Below 220°F (104°C), carburetor ported vacuum should be indicated on gauge.

(2) Above 220°F (104°C), port 1 (Carb.) closes and port 2 (Manifold) is connected to port D (Dist.). Manifold vacuum should now be indicated on gauge.

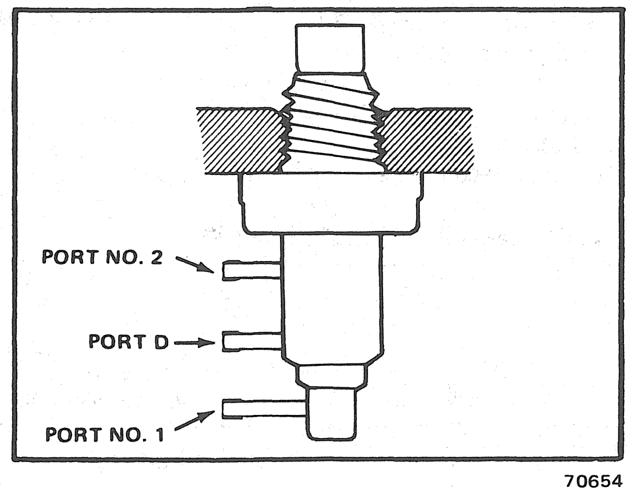


Fig. 1G-22 Spark CTO Valve

Spark CTO Valve Replacement—Six-Cylinder Engine

WARNING: *If engine has been recently operated, use care to prevent scalding by hot coolant. System is pressurized.*

(1) Drain coolant from radiator. Use clean container so that coolant can be reused.

(2) Identify vacuum hoses and disconnect from spark CTO valve.

(3) Place drain pan under engine below CTO valve.

WARNING: *Use care to prevent scalding by hot coolant leaking from block when removing the valve.*

(4) Using 7/8-inch open end wrench, remove valve from intake manifold.

Installation—Six-Cylinder

(5) Install replacement valve.

(6) Connect vacuum hoses to valve.

(7) Install coolant.

NOTE: *Remove temperature gauge sending unit from cylinder head to aid in venting air while filling the cooling system.*

Spark CTO Valve Replacement—Eight-Cylinder Engine

WARNING: *If engine has been recently operated, use care to prevent scalding by hot coolant. System is pressurized.*

(1) Drain coolant from radiator. Use clean container so coolant can be reused.

(2) Remove air cleaner assembly.

(3) Identify vacuum hoses and disconnect from CTO valve.

(4) Using 7/8-inch open end wrench, remove CTO valve from thermostat housing (or intake manifold).

(5) Install replacement CTO valve in thermostat housing (or intake manifold).
(6) Connect vacuum hoses to valve.
(7) Install air cleaner assembly.
(8) Install coolant.
(9) Purge cooling system of air.

Non-Linear Vacuum Regulator (NLVR) Valve

General

On all six- and eight-cylinder engines with NLVR, distributor spark advance is primarily controlled by regulated vacuum (fig. 1G-23). The ratio of the regulation is proportional to the engine load and rpm.

NOTE: *The NLVR valve operates in conjunction with a spark CTO valve.*

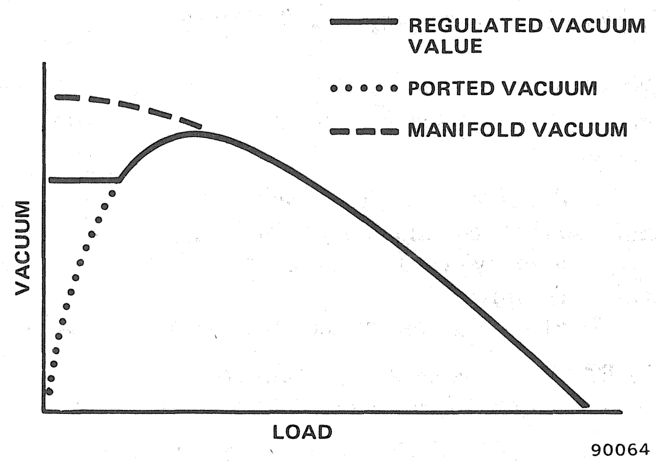


Fig. 1G-23 Non-Linear Vacuum Regulator Valve Operation

Operation

The NLVR valve has two input ports (from manifold vacuum and carburetor ported vacuum sources) and one outlet port (to CTO valve). Under no-load or low-load engine conditions, the NLVR valve provides regulated vacuum (fig. 1G-24). Under these conditions, manifold vacuum is high and ported vacuum is either non-existent or very low. The NLVR valve provides a vacuum that is somewhere between the two vacuum levels. This is determined by the calibration of the valve. As engine load increases and ported vacuum increases above the regulated value, the regulator valve switches to ported vacuum.

Functional Test

Connect a vacuum gauge to the distributor port (D) of the NLVR valve. With the engine at idle speed, a vacuum of approximately 7 in. Hg (24 kPa) should be indicated on the gauge. As the throttle is opened and engine speed increases, ported vacuum from the carburetor should be indicated on the vacuum gauge.

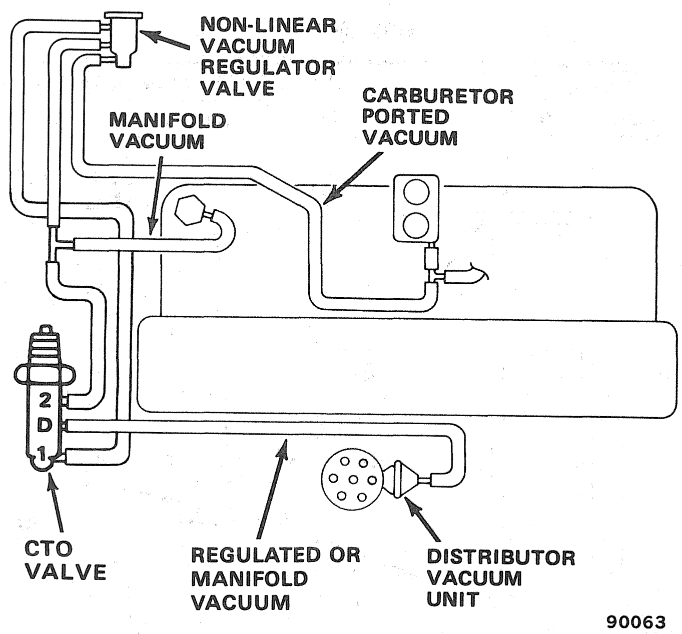


Fig. 1G-24 Regulated Vacuum Spark Control System—Typical

Replacement

(1) Identify and disconnect vacuum hoses and remove NLVR valve.

(2) Connect vacuum hoses to replacement valve.

NOTE: *Ensure vacuum hoses are connected to correct valve ports.*

Forward Delay Valve

Certain engines employ a one-way forward delay valve in the vacuum advance circuit to improve driveability and also reduce undesirable hydrocarbon (HC) emission.

The valve functions to delay the effects of sudden increases in vacuum during quick throttle closings and thereby prevent sudden spark advance during deceleration.

Functional Test

(1) Connect external vacuum source to port on black (or red) side of delay valve.

(2) Connect one end of 24-inch section of rubber hose to vacuum gauge and other end to port on colored side of valve.

(3) With elapsed time device in view and a constant 10 in. Hg (34 kPa) of vacuum applied, note time required for gauge pointer to move from 0 to 8 in. Hg (0 to 27 kPa).

(4) Compare time to acceptable time limits listed in Forward Delay Valve Time Limits Chart.

Forward Delay Valve Time Limits

VALVE BODY COLOR	DELAY TIME IN SECONDS	
	MIN.	MAX.
BLACK/PURPLE	0.3	0.7
BLACK/GRAY	0.6	1.6
BLACK/BROWN	1.0	3.0
RED/BLUE	1.9	5.7
BLACK/WHITE	2.7	9.3
BLACK/YELLOW	4.5	13.2
BLACK/GREEN	8.0	26.0

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NOTE: *While testing delay valves use care to prevent oil or other foreign material from entering vacuum ports.*

(5) Replace valve if it fails test, otherwise, install original with black (or red) side toward vacuum source.

NOTE: *In addition to the valves listed in the chart, certain engine applications employ a two-way delay valve. The body is orange and the minimum and maximum delay time limits are 0.2 to 0.4 seconds.*

Reverse Delay Valve

Along with the forward delay valve, a reverse delay valve is used with certain engines to improve cold engine driveability and to reduce undesirable hydrocarbon (HC) emission.

When an engine is started, manifold vacuum applied to the distributor vacuum advance mechanism advances ignition timing. When the engine is accelerated manifold vacuum decreases causing the ignition timing to be retarded. To prevent the sudden retarding of ignition timing during acceleration, a one-way reverse delay valve is inserted in the vacuum line to delay the effects of the decrease in manifold vacuum.

Functional Test

(1) Connect external vacuum source to port on colored (nonwhite) side of delay valve.

(2) Connect one end of 24-inch section of rubber hose to vacuum gauge and other end to port on white side of valve.

(3) With elapsed time device in view and a constant 10 in. Hg (34 kPa) of vacuum applied, note time required for gauge pointer to move from 0 to 8 in. Hg (0 to 27 kPa).

(4) Compare time to acceptable time limits listed in Reverse Delay Valve Time Limits Chart.

Reverse Delay Valve Time Limits

VALVE BODY COLOR	DELAY TIME IN SECONDS	
	MIN.	MAX.
WHITE/PURPLE	0.3	0.7
WHITE/GRAY	0.6	1.6
WHITE/GOLD	0.8	2.3
WHITE/BROWN	1.0	3.0
WHITE/YELLOW	4.5	13.2
WHITE/RED	14.0	47.2

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NOTE: *While testing delay valves use care to prevent oil or other foreign matter from entering vacuum ports.*

(5) Replace valve if it fails test, otherwise, install original with colored (nonwhite) side toward vacuum source.

SPECIFICATIONS

SPARK CONTROL SYSTEM SPECIFICATIONS
SPARK CTO VALVE CONTINUITY

ENGINE	STANDARD COOLING		HEAVY DUTY COOLING	
	1 To D	2 To D	1 To D	2 To D
4-151	Below 120°F (49°C)	Above 120°F (65°C)	———	———
6-258	Below 149°F (65°C)	Above 149°F (65°C)	Below 220°F (104°C)	Above 220°F (104°C)
8-304	Below 149°F (65°C)	Above 149°F (65°C)	Below 220°F (104°C)	Above 220°F (104°C)
8-360	Below 149°F (65°C)	Above 149°F (65°C)	Below 220°F (104°C)	Above 220°F (104°C)

NOTE: TEMPERATURES ARE NORMAL VALUES

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