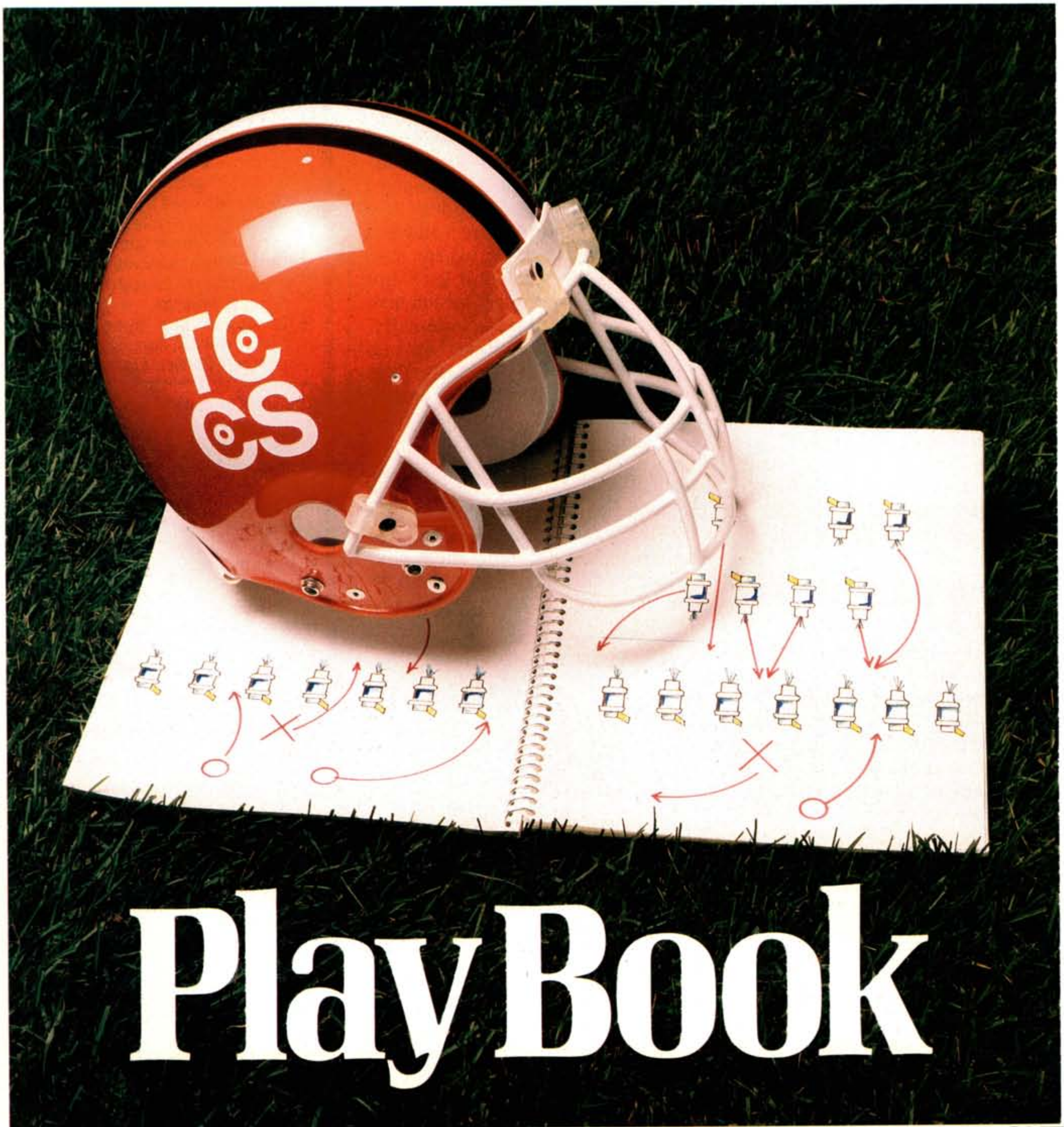



# PlayBook

## PART ONE

We've given you the scouting information on a wide variety of engine management systems in the last few years. By now, you've probably noticed some strong similarities between the systems used by different manufacturers. We know that all engine management systems have the same basic job to do. And the same rules apply, no matter which country the system comes from. It shouldn't come as a big surprise that they often get the job done in very similar ways.

To make a strange comparison, engine management systems are a little like football teams. All the teams in the league must play by the same rules, and there are also regulations governing team size and other factors. But the objective for all teams is the same—win the game. It's the subtle differences in the way each team tries to win that makes following the game interesting.

Each year, the teams develop a set of plays in an effort to gain an advantage over their opponents. They want to make sure that the element of surprise is on their team's side on game day. To keep that element of surprise, the contents of each team's play book is a closely guarded secret.

Working on a new and unfamiliar engine management system can be a little like lining up opposite a team that you've never played against before. You don't know what surprises they're going to throw at you.

This two part article will give you a glimpse inside the TCCS team play book to eliminate some of those surprises. Hopefully, this scouting report will also help you develop your own winning strategies.

## Joining The League

Toyota first joined the National Fuel Injection League with an air flow controlled system introduced on the 1979.5 Supra. The six-cylinder engines on Supras and Cressidas were the first to get the Toyota Computer Controlled System (TCCS) in 1983. More models have gotten TCCS each year as the switch was made from carburetors to fuel injection. Today, even some of the least expensive Toyotas have TCCS.

As the system has developed, additional controls have been added to make it a true engine management system. A recent system may control all of the following:

- Fuel injection duration
- Injection timing
- Ignition spark timing
- Idle speed control
- Exhaust gas recirculation (EGR)
- Electronically Controlled Transmission (ECT)
- Diagnosis

## Diagnostic Codes

As much as we would like to list all the TCCS diagnostic code numbers and descriptions for you, it's just not possible. Individual code numbers can have different meanings from one model to the next even within the same model year. Code meanings and numbers have also been changed from one year to the next as new codes were added and others dropped. Talk about confusion in the huddle.

Fortunately, more recent TCCS systems have begun to unify their diagnostic codes. That means you'll be safe in assuming that the same code number will have the same meaning on all models built within the same model year. For the time being, however, consult the appropriate service manual for the year and model you're diagnosing to get an accurate listing of diagnostic code information.

## Component Abbreviations

It's always easier to refer to EFI components by their abbreviations. The Toyota TCCS component abbreviations aren't entirely similar to the abbreviations used by other manufacturers (teams). We'll list some of the unique TCCS abbreviations with their definitions here in our play book so you'll know what the quarterback is talking about if he calls an audible on the line of scrimmage.

**BVSV**—Bi-metal Vacuum Switching Valve

**ECT**—Electronically Controlled Transmission

**ESA**—Electronic Spark Advance

**ISCV**—Idle Speed Control Valve

**T-VIS**—Toyota Variable Induction System

**TVSV**—Thermostatic Vacuum Switching Valve

**TWC**—Three Way Catalyst

**VCV**—Vacuum Control Valve

**VSV**—Vacuum Switching Valve

**VTV**—Vacuum Transmitting Valve

## Team Photo

We'll begin with a look at the TCCS team's basic operating theory. We can't show you the component locations for every TCCS system. Instead we'll concentrate on a pair of popular team players. You'll see some early TCCS components on a 1986 Camry, and we'll also show you a more up to date 1990 Camry system. Individual components will be in different locations on other Toyota TCCS systems, but system operation will be very similar.

The whole team wouldn't sit still for a team photo, so we've broken things up into five special teams:

• We'll start with the referees and officials who make sure that order and fair play are maintained (the TCCS fuses and relays). They also protect the players from injury.

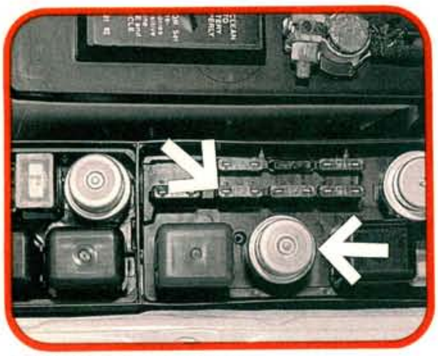
• Next we'll give you a brief description of the head coach (the ECU), his scouts, and his assistant coaches (the ECU's input sensors).

• Then it's onto the playing field for a look at the players (the ECU's control devices).

• After the game is over, the team needs a way to look at what went wrong and what needs to be changed before the next game (self-diagnostic mode and manual adjustments).

• Finally, we'll give you the run down on the players that work the sidelines (non-ECU controlled components). These players don't follow the head coach ECU's instructions, but they can have a big effect on how the game turns out in the fourth quarter.

**—By Karl Seyfert**



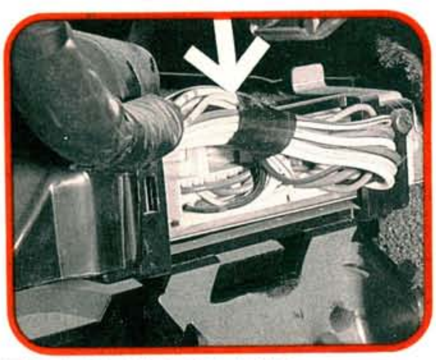
1

### THE REFEREES

The TCCS system won't start until the EFI main relay and fuse say go. Battery voltage must pass through the EFI fuse (left arrow) and main relay (right arrow) before it can reach the ECU, circuit opening relay, and fuel pump. You can spot the round EFI main relay in the underhood relay block on this Camry.

2

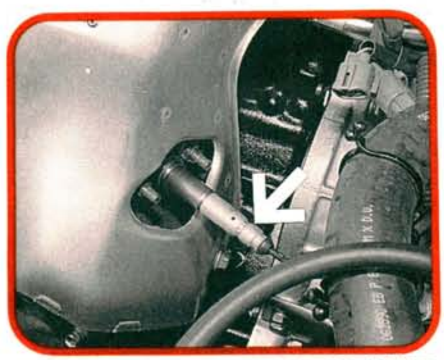
The twin coil circuit opening relay is hidden behind the glove box on this Camry (arrow). The relay controls the voltage supply to the fuel pump. During cranking, the relay's first coil is controlled by the ignition switch. While running, a switch inside the air flow meter controls the ground to the second relay coil.



3

### THE HEAD COACH

The ECU is usually mounted under the center of the dash or behind the glove box. The ECU compares the information from its input sensor scouts to the instructions in its master play book (pre-programmed ROM memory). After considering its options, the ECU sends its instructions to the output control players.



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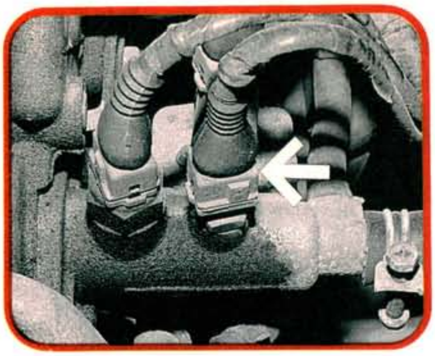
### ASSISTANT COACHES AND SCOUTS

Oxygen sensors can be found in a variety of locations. This Camry sensor has a front row seat in the exhaust manifold, so it doesn't need a heating element to bring it up to operating temperature. Other models may be heated. Some models have two separate oxygen sensors, before and after the converter.



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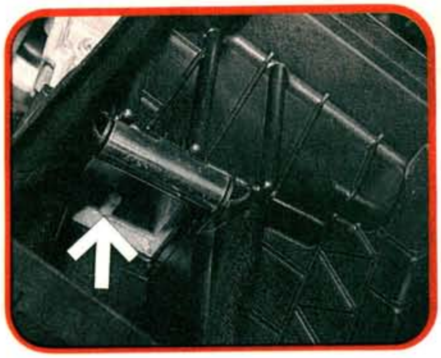
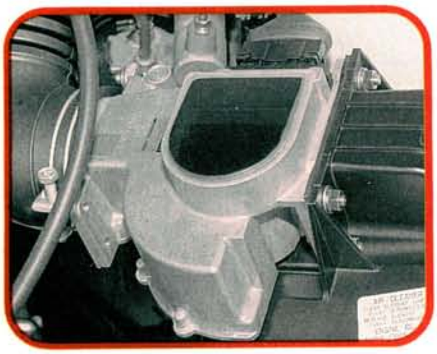
The coolant temperature sensor helps the ECU decide the correct amount of fuel enrichment needed as the engine warms toward operating temperature. The sensor's negative temperature coefficient (NTC) thermistor resistance is high when coolant temperature is low, and decreases as the engine warms.



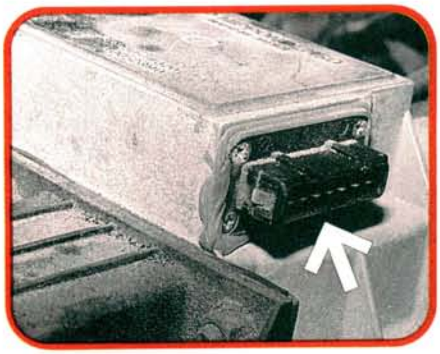
6

The NTC intake air temperature sensor sits in front of the air flow meter's potentiometer air flap. If the air temperature sensor fails, the ECU substitutes a resistance equal to a 65 degree F air temperature. The ECU can also substitute a coolant temperature value to keep the engine running if the coolant sensor fails.



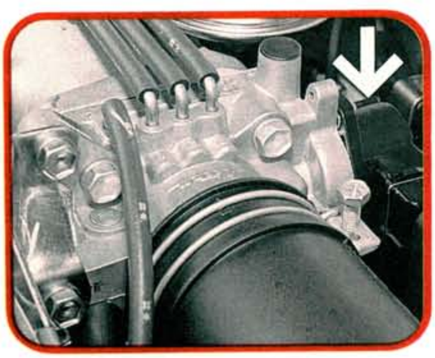
7

Most TCCS systems use an air flow meter to measure engine load. The ECU sends a 5 volt reference signal to the air flow meter. When intake air volume is small (low load), the air flow meter's voltage signal to the ECU is close to 5 volts. When intake air volume is large (high load), the signal voltage is close to zero.



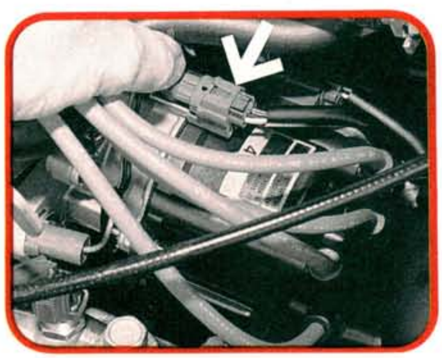
8

The air flow meter also serves a safety function by providing a ground to the circuit opening relay only when the engine is running. If the engine stalls, the air flow meter potentiometer flap closes. The air flow meter's safety switch contacts open, the relay also opens, and power is cut to the fuel pump.



9

The throttle position sensor signals the ECU when the throttle is fully closed. When the throttle is opened, a potentiometer returns a varying voltage signal to the ECU, used by the ECU to determine throttle opening angle. Knowing the throttle opening angle helps the ECU determine the engine load.

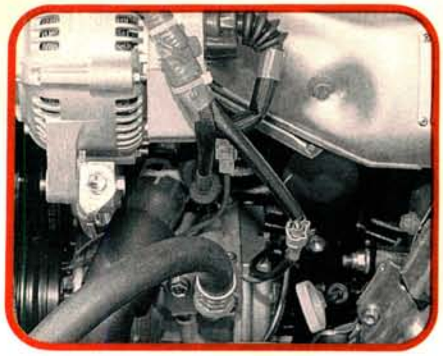


10

The distributor signals the ECU using its NE and G sensors. The NE sensor gives the ECU an engine speed signal. The ECU uses the G sensor signal (crankshaft angle) to help determine proper injection and ignition timing. Some distributors have two G sensors, giving the ECU two separate crankshaft angle signals.

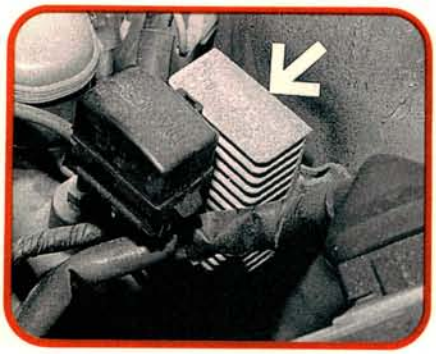

11

The vehicle speed sensor in the speedometer head uses induction to generate a series of pulsed signals as the speedometer cable turns. The ECU translates the frequency of the speed sensor's pulsed signals to determine the vehicle's speed.



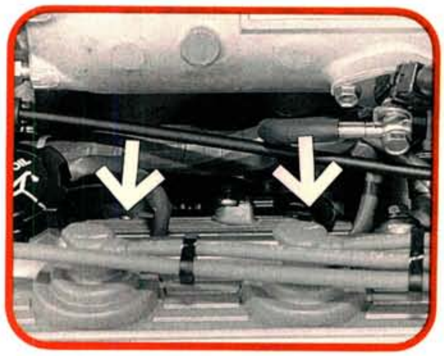
12

The ECU also keeps tabs on the air conditioning compressor, headlights, rear window defogger, and brake light circuit. The ECU responds to changes in engine electrical load by adjusting the engine speed. The neutral start switch also lets the ECU know which gear the transmission is in.



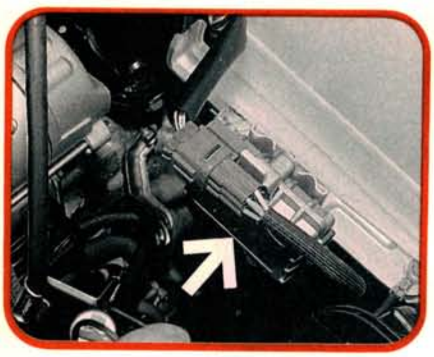
13

Early TCCS systems used a solenoid resistor (arrow) wired in series with the injector voltage supply circuit because the injectors have a low internal resistance (about 2 ohms). Recent models have switched to a high resistance injector (about 14 ohms), and the solenoid resistor has been eliminated.



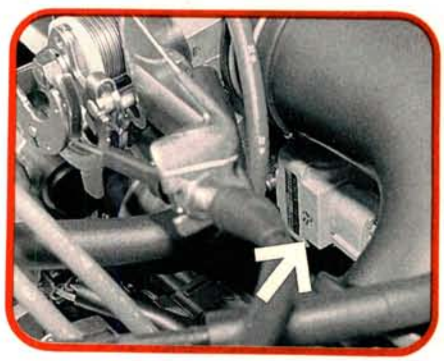
14

The nozzle design has also been changed on later injectors. Fuel is injected through two holes for better atomization. The new two hole injector design resists fuel deposit clogging better than early pintle valve injectors. Fuel pressure has also been increased on some models to prevent fuel percolation.



15

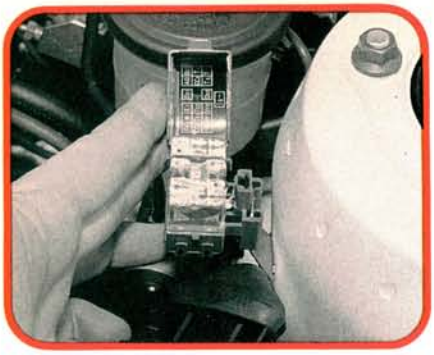
The ignition system igniter is mounted outside the distributor (arrow). The ECU energizes the coil primary windings by switching the igniter off and on. Some systems send an ignition confirmation signal back to the ECU each time the coil fires. If the ECU doesn't receive the signal, it shuts off the injectors.



16

The rotary idle speed control valve (ISCV) used on later systems controls idle speed from cold to normal engine operating temperature. The ECU constantly adjusts the ISCV to maintain a steady idle speed as engine load changes. The idle air bypass valve used for cold starts on early systems has been eliminated.

## 17

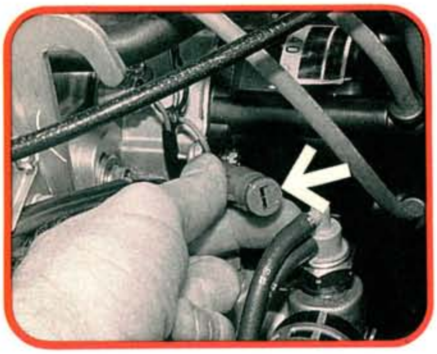


The check connector provides a convenient window into the TCCS system. Early systems use a two pin connector. Stored diagnostic codes are recalled by bridging the connector's T and E1 terminals with a jumper wire. This late model Camry's multi-pin connector can also be used to test the fuel pump circuit.

## 18

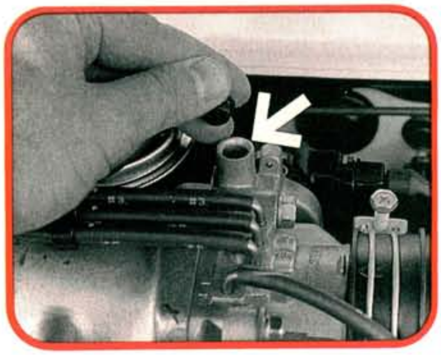

The dash-mounted check engine light flashes two digit diagnostic codes to signal problem areas. When two or more codes are stored in the ECU's memory, the lowest code always flashes first. All diagnostic codes except code 51 are held in the ECU's memory until they are erased.

## 19



Base idle speed is set by bridging terminals T and E1 at the check connector with the engine running. This switches the system into a base operating mode. Use the green lead (arrow) at the side of the distributor for your tachometer hookup. Also adjust base timing with the check connector terminals bridged.

## 20



The base idle adjusting screw is hidden under a rubber plug in the throttle housing. Don't confuse this adjustment with the A/C idle-up solenoid valve at the other end of the intake manifold on early systems. Idle CO percent can also be adjusted after removing the air flow meter's protective plug.

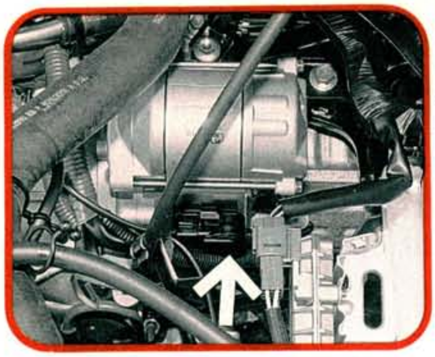
## 21

### THESE PLAYERS DON'T LISTEN TO THE ECU'S INSTRUCTIONS

The bimetal idle air bypass valve used on early systems gives the engine a fast idle during warm-up. The ECU doesn't control bypass valve operation and has to wait for the engine to reach operating temperature before it can adjust the air/fuel ratio.

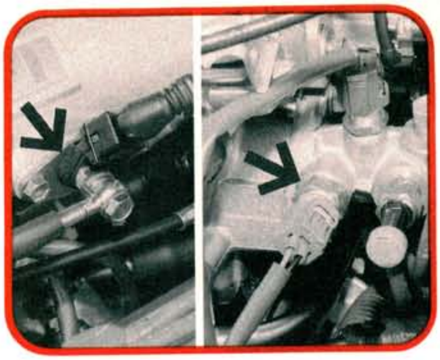
## 22

Fuel pressure is controlled by a vacuum operated pressure regulator. The regulator increases fuel pressure as engine load increases and manifold vacuum decreases. Most systems run at about 36 PSI at idle. Some later systems raise fuel pressure during hot restarts to prevent fuel percolation problems.



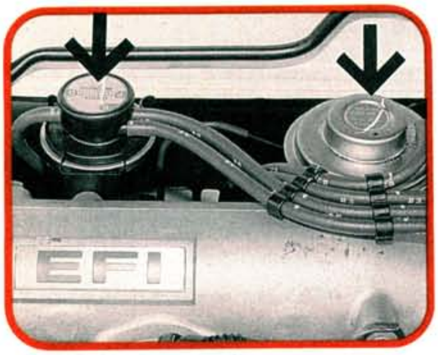
23

The ignition switch does more than control the starter solenoid (arrow). During cranking, current also flows to the cold start injector, thermo-time switch, and one relay coil of the circuit opening relay. To prevent engine flooding, current flow is cut to all three in any other ignition switch position.



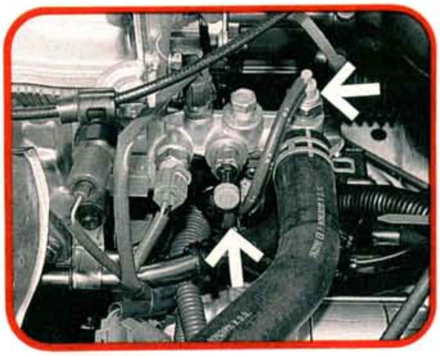
24

TCCS systems use a cold start injector to help out with cold engine starting. The injector's operation is controlled by the thermo-time switch and the ignition switch on most models. The ECU may also control the injector operation over a limited temperature range on some later systems.




25

A vacuum controlled EGR modulator valve (arrow) regulates the EGR valve operation. California systems include a temperature sensor in the EGR passage downstream from the EGR valve. If the EGR valve stops working or the passage is clogged, the drop in temperature causes the sensor to signal the ECU.



26

Vapor canister purge and EGR modulator valve operation are limited by a pair of bi-metal vacuum switching valves (BVSVs), mounted next to the coolant temperature sensor on this Camry system. Both BVSVs block the vacuum supply until the engine reaches operating temperature.