INTRODUCTION

One of the most important developments in the automotive service industry is the use of computerized engine controls. These systems constantly adjust fuel, ignition and emission systems, resulting in better fuel economy, increased performance and reduced emissions. Another result of the computer systems is an ever-increasing load of wiring, sensors and solenoids in the engine compartment. The aim of this section is to help untangle both the computer systems and the fear with which most servicemen approach them.

The traditional "tune-up" is performed to help improve engine operating efficiency. In vehicles with computerized engine controls, the computer is constantly tuning the engine. However, the tune-up abilities of computer systems vary greatly. Some systems only affect air/fuel ratios. Others can also control things like air injection and EGR operation. On the most sophisticated models, the computer controls fuel injection, air-/fuel ratio, ignition dwell and timing, air injection, EGR, canister purge and other functions.

This introduction will cover the major components of computer systems, some basic servicing tips and list some necessary tools.

CONTROL UNITS

The heart of any computer system is the control unit, or control module. These computers are usually sealed in a metal box and are linked to the system by a wiring harness with multi-pin connector. The computers on most Ford and Chrysler Corp. vehicles are in the engine compartment, while General Motors, AMC, and Ford EEC-III computers are located in the passenger compartment (for protection from temperature and vibration).

Some units have a replaceable programming section, referred to as a PROM (GM) or Calibration Assembly (Ford). These plug into the main computer and "tailor" the programming to fit specific emission requirements or vehicle equipment.

The function of the computer is to coordinate engine equipment and operation. During certain operating conditions, the computer operates in what is called "Closed Loop". This indicates that the computer is actually "running" the engine, based on information received from the various sensors. At other times, the computer operates in "Open Loop", where preprogrammed information in the computer is used for governing engine operation.

SENSORS

The computer receives information from its sensors. Most sensors are simple sending units that are either grounded or open (like an oil pressure switch) or provide a varying resistance (like a fuel gauge sending unit). Some engine data comes from existing sensors (engine temperature) or a connection to an existing circuit (coil or distributor pick-up).

On some systems (Ford EEC), the computer sends a reference voltage out to each sensor. Varying resistance in the sensor drops the voltage a certain amount, and the computer uses the return voltage as a signal.

Computer decisions are based on the pre-programmed information put in by the manufacturer and sensor input. The most common sensor inputs include:

- Air/Fuel Ratio (from oxygen sensor)
- Engine Speed (from distributor or crankshaft sensor)
- Engine Temperature
- Engine Load or Vacuum
- Throttle Position

Other sensors are used by some systems to provide additional information. Some of these are:

- Intake Air Temperature
- Intake Air Flow
- Barometric/Manifold Pressure
- Vehicle Speed
- Fuel Temperature and Pressure
- Detonation
- Transmission Gear Position

Two different systems may both require the same input, but use different sensors to obtain it. For example, one of Ford's MCU systems uses an Idle Tracking switch to tell the computer when the throttle is against the idle stop. Another MCU system uses a vacuum switch which provides the same information. In spite of the variety of sensors, computers make their decisions based on the same kinds of inputs.

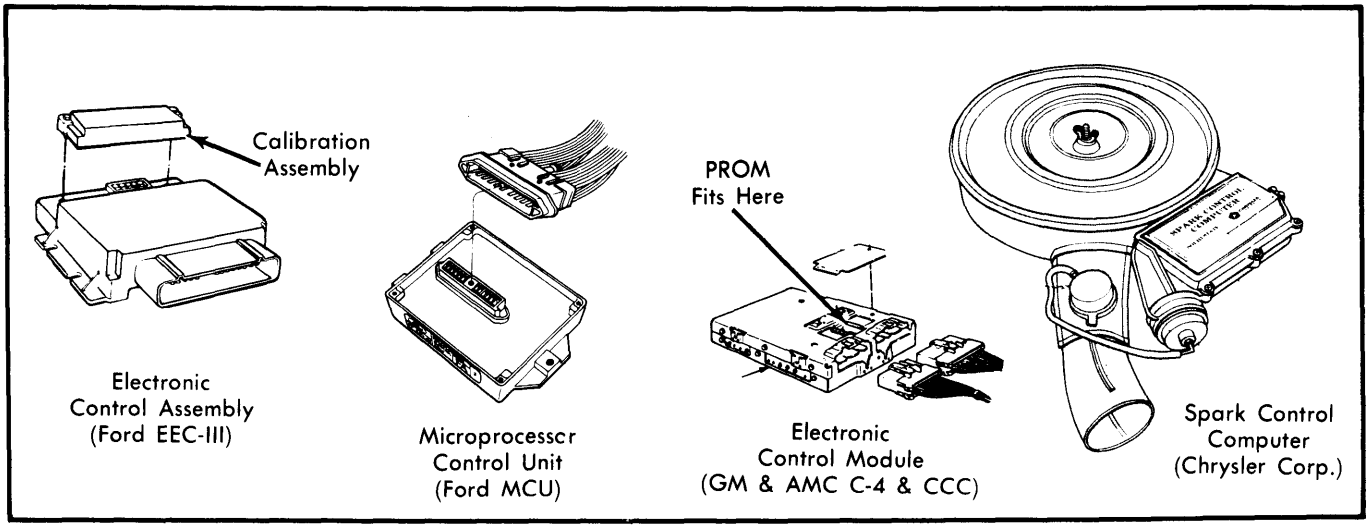

Fig. 1 Control Units for Computerized Engine Controls

INTRODUCTION (Cont.)

ENGINE CONTROLS

Computer commands are carried out by solenoids, motors, and other control devices. Solenoids are used for many functions: vacuum control, air bleeds, carburetor fuel flow, etc. Motors are used for idle speed control and mixture adjustment.

Computers control some functions directly, while others are accomplished by more involved means. For example, some systems are capable of retarding ignition advance when detonation ("knocking") is sensed. On one system (Ford 6 Cyl. MCU), the computer activates a solenoid which cuts off vacuum to the distributor advance diaphragm. On another (General Motors CCC), the computer sends an electrical signal directly to the ignition module, which results in a delayed spark. The method used is different, but the end result is the same.

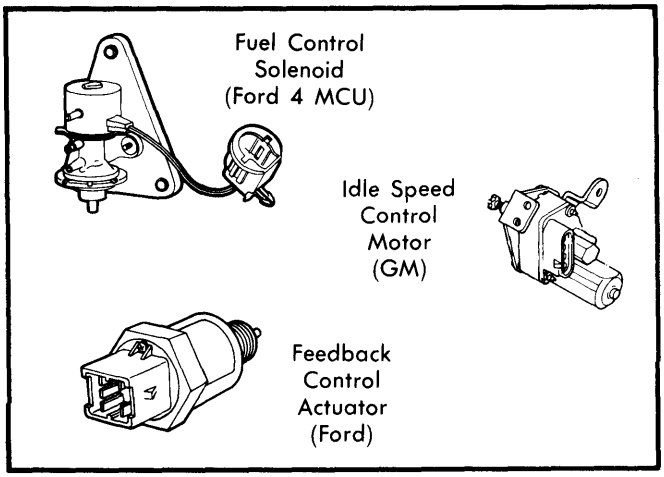

Fig. 2 Engine Control Solenoids & Motors

Some computer systems (Chrysler 6 Cyl. EFC and Ford 4 Cyl. MCU) control mixture by vacuum. A vacuum regulator is controlled by the computer, and provides a vacuum signal to a mixture control diaphragm in the carburetor. In another system (General Motors CCC), the computer controls a mixture solenoid in the carburetor with electrical signals, and no vacuum is needed. Servicing procedures will vary between these two systems, but the computer controls the mixture in both cases.

SERVICING

Most computerized engine control systems have no serviceable parts. The technician's job is confined to locating the defective part and replacing it. Since these systems can be quite complicated, most manufacturers provide a diagnostic program in the computer which allows it to locate its own problems.

With these systems, the technician starts the computer diagnosis program and then watches for service codes that identify the problem. Once the codes are known, trouble shooting charts are used to locate the specific failure. Without the diagnostic program and charts, repairs can still be made, but they will be much more time-consuming.

TOOLS

Some systems require special testers (Ford EEC and Chrysler ESC), but most require only common shop equipment. The following items are necessary for servicing most systems:

- Digital Volt-Ohmmeter (At least 10 megohms input impedance)
- Vacuum Gauge
- Vacuum Pump
- Timing Light
- Test Lamp
- Tachometer/Dwell Meter
- Jumper Wire

The most important tool in servicing is the alertness of the servicemen. Many problems are caused by poor connections and damaged wiring or hoses. A complete visual check should be made before assuming that the computer or system has failed.

COMPONENT TESTING

Since it is not possible for a computer to be tested in the field, most servicing approaches are designed to eliminate all other causes of trouble, and then recommend replacing the computer. In order to do this, some components must be tested.

Sensors can be checked by seeing if they open or close at the right time, or if their resistance values are correct. Solenoids can be checked by applying voltage with a jumper wire and watching to see if they operate. Solenoids should have a measureable resistance — that is the windings should not be shorted to ground or open.

If sensors and solenoids are okay, circuit wiring should be checked. Disconnect wiring at both ends of a circuit and measure resistance of the circuit. If more than about 5 ohms, connections need to be cleaned or wires repaired. Then connect the ohmmeter between one end of the circuit and ground. If resistance is less than several hundred thousand ohms, the wire is shorted to ground and must be repaired. Wiring diagrams are available for all systems and should be used to check connections and resistance values.

If all sensors, control devices, and wiring are good, the control unit or computer is suspect. If possible, substitute a known good unit. If vehicle performance improves, install a new unit. Since control units are expensive, be sure all other possible causes of failure have been checked before replacing one.

SUMMARY

Computerized engine controls are becoming common and may soon be used on all engines. The computer is simply a decision-making unit that receives information from sensors and sends commands to control devices. Although control units perform many of the "tuning" functions once performed by a service technician, they have not eliminated the competent repairman. A great service opportunity is waiting for people who, with the proper resources, can accurately diagnose and repair computerized engine control systems.